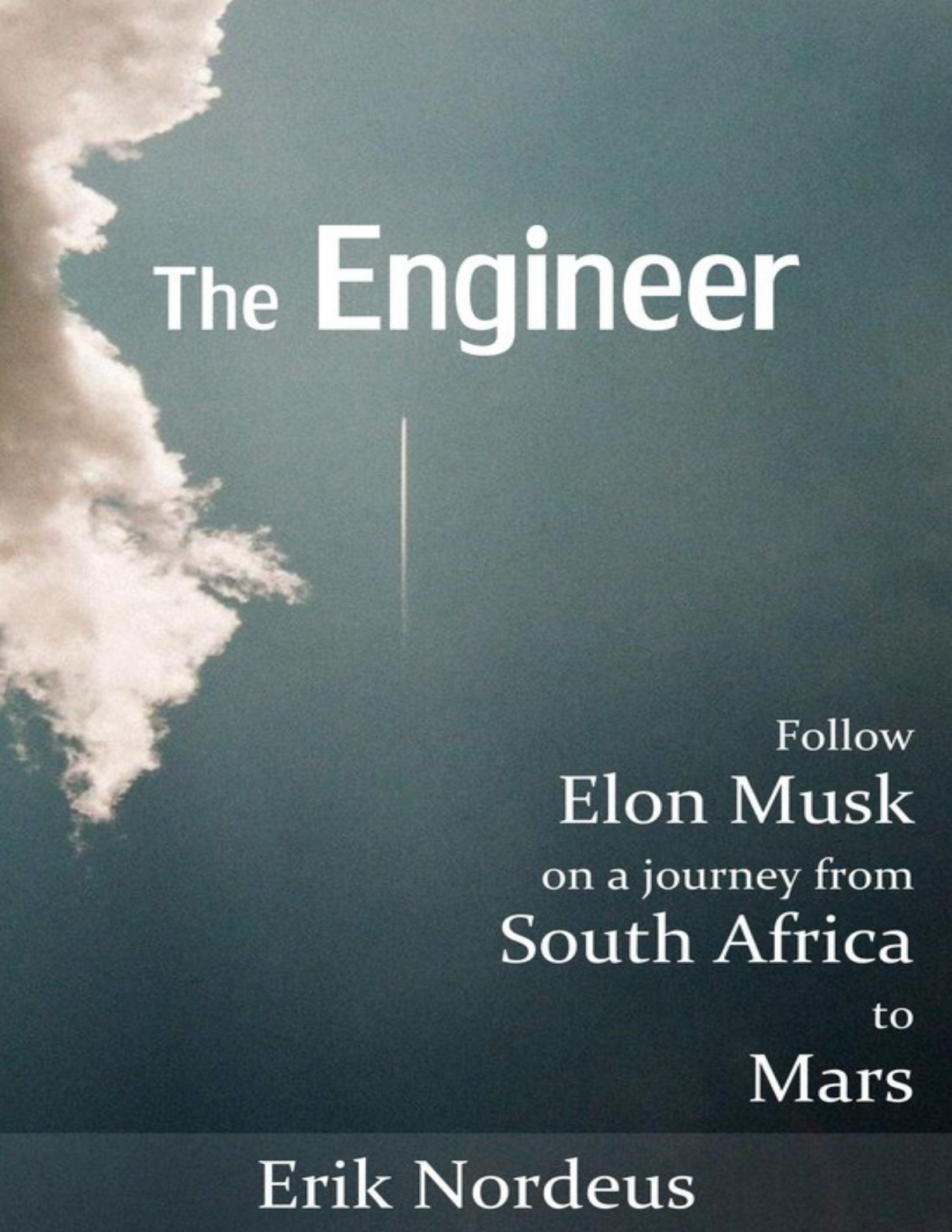
The Engineer
Follow
Elon Musk
on a journey from
South Africa
to
Mars
Erik Nordeus

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The Engineer

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Table of Contents

Preface

Introduction

Sand Hill Road

Lost Cities

Boredom Leads to Great Things

What Do I Do Now?

The Meaning of Life

The Outsider

Joining the Mafia

I Don’t Need These Russians

Launching a Truck Into Space

The Electric Stars

You Can’t Sell a Car That Looks Like Crap

Tesla’s Macintosh

Trouble in Paradise

Iceberg, Right Ahead

Another Iceberg, Right Ahead

Revenge

Halfway to Anywhere

The Leaning Factories

A Burning Man

Joining the Thrillionaires

Idea Overload

End of the Beginning

Timeline
- Elon Musk
- Tesla Motors
- SpaceX

Sources

Preface

The history of *The Engineer - Follow Elon Musk on a journey from South Africa to Mars* began in 2006 when I read a book about peak oil. The idea behind peak oil is that the world sooner or later will run out of oil because oil is a finite resource. Most books written on the subject are within the doomsday category. The book I read argued that when there's no more oil we would be forced to return to a 19th century society. Horses would be the main mode of transportation because the alternatives, such as electric cars, wouldn't make a difference because they weren't good enough.

Peak oil terrified me. The first night I had nightmares about how the world would look like without any vehicles. How would we deliver food? How would we build houses? How would we transport injured people? I watched every day how the price of oil climbed to record levels. But when the 2008 credit crisis hit the world, the price of oil decreased from $150 per barrel, and nightmares about derivatives replaced my nightmares about peak oil.

Fast forward to late 2012. One dark autumn night I watched a video on YouTube where the entrepreneur Kevin Rose interviewed a guy called Elon Musk. I had never heard of him or his companies before. At the end of the interview, Elon mentioned that he worked with the Hyperloop - a fifth mode of transportation, where the other modes are train, boat, road, and aircraft. This sounded interesting to the engineer in me, so I needed to learn more about him.

After reading a few articles, I realized that Elon was well aware of peak oil. He had even designed an electric car that could replace a gasoline car. The book I had read about peak oil was wrong! To learn more about Elon, I searched for if someone had written a biography. The only books I found were those biographies where the author has copied only what's available on Wikipedia. I began reading more articles and watching more videos, and I realized it existed so much information I might as well write a real biography.

But this is not just a book about Elon as it has several other purposes. Elon himself said, "I think you have to enjoy what you are doing. Otherwise, it is hard to do it. There are three things you look for. You have to look

forward in the morning to doing your work. You do want to have a significant financial reward. And you want to have a possible effect on the world. If you can find all three, you have something you can tell your children."

I believe this book may have a positive effect on the world. The first purpose with the book is to motivate young people to become engineers. It has been estimated that Europe will lack 500 000 engineers by 2020, and I believe the solution is inspiration.

During my first year in engineering school, each student had to read a book on the Nobel Prize. I don't recall the purpose; maybe someone thought we would become more motivated? But the book had almost the opposite effect - we became less motivated. The characters in the book were no role models we could find any inspiration from. Elon, on the other hand, is a true role model. Will Elon ever get a Nobel Prize? If he doesn't get it, will he be sad about it? He might, but then he jumps into his Tesla Roadster, drives to the airport, boards his private jet, flies to the nearest spaceport where he enters a rocket on its way to a new civilization on Mars. That's inspiring.

The second purpose with this book is to motivate engineers to become entrepreneurs and tackle the larger, more expensive, and difficult problems. I believe there are professional engineers who have great ideas, but they don't know they can build a company from those ideas. If Elon can build two Internet companies, a rocket company, a car company, and a solar company - why can't you?

Another purpose is to explain the why of things. The problem is that not everyone understands Elon and his companies. How can you convince someone to buy an electric car if he or she at the same time believes the supply of oil is infinite? Elon himself said, "If you could explain the why of things then that makes a huge difference to people's motivation."[353] So someone has to explain why we need to move away from a society dependent on oil. Why do we need to build rockets and colonize Mars? Elon has tried to explain everything by giving countless interviews, but it's difficult to understand the big picture from articles and videos. I hope that you who read this book will soon understand the big picture behind Elon.

I also believe the author of a biography on Elon has to be an engineer. I've read articles by non-engineers (I suspect) that confuses different topics. One example is that several articles argued that Elon became interested in electric cars to save the environment. But that's not true. Elon became

interested in electric cars because the world is running out of oil. During one interview, he had to hang up the phone because the journalist couldn't understand the difficult topics. But don't worry - you don't need to be an engineer to read this book.

I've used 457 sources to write this biography. The goal is that everything in the book is as truthful as it can be in an unofficial biography. But since it's after all rocket science, some factual errors may exist. If you find an error, I'm happy to correct it as soon as possible.

Several conflicts have happened throughout Elon's life, including divorces and angry employees. When describing these conflicts, I've tried to be as neutral as possible by including the views from both sides.

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Introduction

"I think we're going to the Moon because it's in the nature of the human being to face challenges. It's by the nature of his deep inner soul. Yes, we are required to do these things just as salmon swim upstream."
Neil Armstrong
"All our dreams can come true, if we have the courage to pursue them."
Walt Disney

A dictionary defines an engineer: "A professional practitioner of engineering, concerned with applying scientific knowledge, mathematics, and ingenuity to develop solutions for technical problems. Engineers design materials, structures, and systems while considering the limitations imposed by practicality, regulation, safety, and cost. The word engineer is derived from the Latin roots *ingeniare* [to contrive, devise] and *ingenium* [cleverness]."[391]

This is a book about the beginning of a journey. Elon Musk is the main person in the journey through a roller-coaster life. His journey includes everything from Winston Churchill's adventures in British colonies to demolished sports cars. From failed marriages to German scientists escaping from the Red Army. From the oil industry to the Burning Man festival.

Elon has been described as the Steve Jobs of heavy industry, as a modern version of the scientist Nikola Tesla, and as the Henry Ford of rockets. There's a high probability that the British Secret Intelligence Service has a file on him. As the files of other James Bond villains, it describes secret rocket launches in the Pacific Ocean. But Elon doesn't own a white cat - he's more of a dog person. Maybe the most comparable persons are the great explorers who voyaged across the globe. They had an entrepreneurial spirit, were a little crazy, tried what no one else had tried, and thought what no one else had thought.

If you want to describe the companies Elon has founded with one theme, you can say that they improve the world with the help of innovative technologies. This is exactly what our world needs.

The history of mankind begins about 50 000 years ago. We know little of the first 40 000 years, except at the end of them, we had learned to use the skins of animals. Then we emerged from our caves to construct other kinds of shelter. 5 000 years ago, we learned how to write and how to use a cart with wheels. Now began the acceleration of technological progress. Within only a few hundred years, we invented the steam engine, electric lights, telephones, cars, and airplanes. In the last few years, we developed penicillin, television, and nuclear power.[19]

Then something happened. Everyone forgot the larger problems and began to focus on the smaller problems. The computer in a modern phone is more powerful than the computer in the craft that landed on the Moon, but we are only using the power to fire birds against pigs and to watch pictures showing what our friends ate for breakfast. Was it that future we wanted? In a famous speech, the former US President John F. Kennedy said, “So it is not surprising that some would have us stay where we are a little longer to rest, to wait. But this city of Houston, this State of Texas, this country of the United States was not built by those who waited and rested and wished to look behind them. This country was conquered by those who moved forward.”[19]

We are no longer moving forward with ever-greater speed, we are moving slower. The Concorde could fly across the Atlantic Ocean in three hours, and the commercial said, “The world is now a smaller place.” But with the decommissioning of the Concorde in 2003, the world is now a larger place. We’re not just flying slower, other modes of transportation are also moving slower. The US state of California ordered a bullet train that would be one of the slowest bullet trains in the world at the highest cost per mile.

The world has not just become a larger place; we are also destroying the world. One explanation to why we no longer are moving faster is because we are using expensive, dirty, and sometimes dangerous energy sources. We are not only using nuclear power plants, we are a world dependent on oil. The problem is that oil is a finite natural resource we are running out of, and we may begin to run out of it as soon as 2020. Unless we want to start using horses, we need to design technology that doesn’t rely on oil.

The question is why we are focusing on the smaller problems and forget the larger ones. One of the reasons might be that it’s complicated and more

expensive to build an electric car, while it's less expensive to build yet another Facebook clone. Another reason might be that we are satisfied with what we have. We don't have to replace the world's oil dependency today. But what happens when we need to? What if we need to leave the planet because something has happened or will happen to it. Then we have to trust that someone has the answers to these larger problems no one cares about today.

But someone who cares about these larger problems is Elon. He knows how we can replace our dependency on oil. He knows how we can colonize Mars and escape to the red planet if something happens to Earth. To yet again make the world a smaller place, he has designed an aircraft that's faster than the Concorde.

The difference between Elon and other pundits is that he realizes his ideas. To save the world from its oil dependency, he's creating companies with exactly that purpose. To be able to escape to Mars, he has already begun building the rockets needed. To make the world a smaller place, he will release the technology for free. The rest of the world needs to just sit back and enjoy the ride.

Sand Hill Road

You can find several stories about the engineer Elon Musk. One of them took place on and around the Sand Hill Road in California. It goes like this:

A 28-year-old Elon wanted to buy a new car. The price of the car wasn't important because he didn't need to think about money anymore. He had just made $22 million from selling his company.[327] His garage had already included a 1967 Series 1 E-type Jaguar, which is considered to have the best car design ever made. Now he wanted the fastest car he could find.

A magnesium silver McLaren F1 met his requirements. The British made McLaren F1 is essentially a road-ready version of a racing car from the Formula One World Championship. With a top speed of 231 mph [372 km/h], it set a record in 1998 as the fastest road car in the world. It only takes 3.2 seconds to reach 60 mph [100 km/h].

It was a close call when Elon bought his dream car. The fashion designer Ralph Lauren tried to buy the same one, but Elon signed the deal one hour earlier.[263] When McLaren began selling it, the fortunate customers paid one million dollars to get one. But since only 106 cars were ever manufactured, the price today can be as high as four million dollars. Elon bought number 67.[10]

A large black truck delivered the McLaren F1 to Elon's home. He was now famous in Silicon Valley, so a film crew behind the documentary *Silicon Valley Gold Rush* followed each step. Like a boy before Christmas, Elon jumped around the truck while the car was unloaded. The first person who walked by said, "Is that a McLaren F1? Oh my God. That's unbelievable." Elon was happy. "Wow, I can't believe it's actually here," he said. "That's pretty wild man. Just three years ago, I was showering at the YMCA and sleeping on the office floor, and now I got a million dollar car."[27]

Enthusiasts described the McLaren F1 as the purest super car ever manufactured. This may sometimes be a drawback with owning one because enthusiasts chase them like a paparazzi chasing a movie star. "I lined up next

to one at a light in Palo Alto a few months ago," a proud enthusiast said. "I think it was the one that belongs to the X.com/PayPal founder guy [Elon Musk]. Made my day."[9]

Seeing the car in Silicon Valley wasn't anything unusual. The region has the largest density of McLaren F1 in the world. "I'm more excited about seeing this car than I have ever been about anything else," another enthusiast said. "Nothing else compares at all. As he [Elon Musk] braked for the 90-degree right to get on the freeway, the rear diffuser popped up exposing its gold foil covered underside. That sent a chill up my spine – go ahead – laugh all you want. When he decided he'd had enough of me tagging along beside him he practically disappeared down the FWY. Considering he's got about five times the power of my car, I just let him go."[111]

In 2000, Elon drove his McLaren F1 along Sand Hill Road. Located in California, the Sand Hill Road has the same appeal as Wall Street in New York. Venture capitalist companies flock to the road, and it provides easy access to the Stanford University and Silicon Valley. During the height of the tech bubble – when the difference between being the next big thing and looking like it didn't matter – the commercial real estates on Sand Hill Road were more expensive than almost anywhere else in the world. The prices were so high it would be less expensive to live on Manhattan in New York. It was impossible to find vacant office spaces or any legal places to park. Those who could afford to live in the area accepted the cost of parking tickets as part of the high price of living there. But money wasn't a problem for most people. You could hear comments like, "Let's call our team Gold Rush because we all want to make a lot of money."[167]

Together with Elon in the car sat his friend and co-worker Peter Thiel. They were on their way to the famous venture capital firm Sequoia Capital where they would brainstorm fund-raising strategies. Thiel sat in one of the two passenger seats. The driver in a McLaren F1 is sitting in the middle of the car in a seat personally customized for each owner. Slightly behind the driver, there are two passenger seats on each side of the driver's seat.[8,123]

"So what can this do?" Thiel asked Elon after a fifteen-minute demonstration of the car.

"Watch this," Elon replied and floored the gas pedal.

The McLaren F1 has no traction control because the car is designed for maximum performance, so the car began to spin after a lane change. Elon did what he could to avoid the other cars driving on the same road while he at the

same time tried to control the spinning car. After some terrifying seconds, the McLaren F1 slammed into the embankment of the road. The car lifted from the ground and began rotating like a discus flying through the air. They finally crashed down on the ground.[328]

When the dust cleared, Thiel heard how Elon laughed. Thiel asked him why he laughed when he had just wrecked his new dream car. “You don’t know the funny part, it wasn’t even insured,” Elon replied.[328] It’s unclear exactly why he laughed. One reason might have been the shock from the traumatic event that had just happened. Another reason can be explained with the new word “muskitude,” defined as a supercilious attitude caused by having made too much money too young.[301] It might have been a combination of both.

Elon and Thiel survived the crash without any major injuries. “The first woman who saw us thought we were dead, and the whole thing felt like a roller coaster gone a little bit out of control,” Thiel said.[8] Before the emergency services arrived to the scene, Thiel opened the gull-winged door, stepped out of the car, and hitchhiked a ride to not miss the meeting with Sequoia Capital. Elon also hitchhiked a ride to the meeting once a tow truck arrived to the scene.

Despite the dramatic accident, the McLaren factory could repair the damaged car. The car’s main body had survived, but the front and the suspension were damaged. After the brief detour to the workshop, Elon began using the McLaren F1 as his daily driver to and home from work.

Another unfortunate McLaren F1 driver was the British comedian and actor Rowan Atkinson, also known as Mr. Bean. His black McLaren F1, number 61, has crashed twice. Luckily he survived the accidents without any major injuries, but his insurance company had to pay the most expensive insurance payout ever recorded in Britain.[6] In favor of Atkinson’s driving skills, he has driven the car since 1997, covering a distance of 37 000 miles [60 000 km]. It’s probably a world record among McLaren F1 owners.[7]

While Atkinson competes with other sports cars on a racetrack, Elon never participated in a race with his car. Elon, however, once tried to see how fast he could drive it on an airstrip, and he pushed the McLaren F1 to speeds of 215 mph [346 km/h].[4]

In 2007, Elon felt he had to sell his beloved McLaren F1. As the manager of a company manufacturing environmental friendly cars, he wanted

to improve his image. “It was an environmental decision,” he said. “My McLaren F1 was a great car. It was a work of art, really, but it’s not good for the environment and I didn’t want people always writing that I have a high-performance gasoline sports car, so I decided to sell it.”[69]

Number 67 wasn’t more safe with its new owner. After six months of winter storage in a garage, the new owner wanted to take it out for a spin. A passing onlooker alerted the driver that smoke came out of the rear engine compartment. As the owner jumped out, the fire spread quickly, destroying large parts of the car. Since the car is a collectibles item, the McLaren factory had to save it yet again. But there’s no need to feel sad for the owner while the car was repaired – the owner had one McLaren F1 in reserve.[5]

So who said it was dull to be an engineer?

Lost Cities

It's funny how distant events can affect the modern world. In the late 12th century, surnames became necessary when the English government introduced personal taxation. It was common that families from the upper class took the titles of their domains as surname, such as Lancaster or Locksley, while artisans took their surnames from what they were working with, such as Smith or Taylor.[13] The surname Musk, however, originates from one of the oldest surnames ever recorded in England.

Led by Duke William II of Normandy, Normans and French troops invaded England. The final battle of the war was the Battle of Hastings where the invading army defeated King Harold II of England. It was now in the year of 1066 the origin of the surname Musk was introduced to England. Originally a nickname to distinguish a younger person from an older bearer of the name, the Norman-French word "le meschin" means "the younger." The first written record of the surname is that of William le Meschin, who was an English feudal baron. As time passed, the surname le Meschin altered to surnames such as Musk, Misk, or Miskin.[72]

Elon Musk's family can be traced back to as early as the 18th century when Henry Musk married Mary Faulkner. They lived in England and they had four children, and one of the children was Henry Musk the younger.[96]

Henry Musk married Charlotte Lane in 1824. They lived in Exning, a small village in Suffolk, England. One of their thirteen children was Eliza Musk, born in 1844.

Eliza Musk's husband is unknown. She never married since she kept her maiden name. What is known is that she worked as a servant in London, but she had three children while she was still living in Exning. One of these children was Harry Musk, born in 1863. He worked as a bricklayer before he moved to an area known today as South Africa.

As the first European, the Dutch Jan van Riebeeck settled in a region known today as South Africa. He arrived in 1652 and established the Cape Colony. The purpose of the colony was to re-supply the ships from the Dutch East India Company with fresh provisions, almost like a charging station for

electric vehicles.[75] As the Suez Canal had not yet been constructed; ships had to sail around the entire African continent to get to their destinations. The risks involved with sailing around Africa was the main reason why Christopher Columbus tried to find a faster route by sailing west from Europe. Since Columbus failed to find a shorter route, the Cape Colony became an important region.

In the beginning of the 19th century, the British Empire took control of the Cape Colony during the Napoleonic Wars, and British immigrants began to move there. Most emigrated from England because of financial reasons and they chose between America and the Cape Colony as their destination. "These are regions of possibility, and as we drove along before our now friendly wind I could not but speculate on the future," Winston Churchill wrote while traveling through the southern parts of Africa. "Here are wide tracts of fertile soil watered by abundant rains… while Englishmen choke and fester in crowded cities, while thousands of babies are born every month who are never to have a fair chance in life."[11]

Led by the discovery of vast amounts of commodities, primarily gold and diamonds, the region's economy grew fast during the 19th century.[75] Because of these natural resources, and as often happens when humans become greedy, several conflicts broke out.

Between 1899 and 1902, the British Empire and the Boers fought each other in a conflict known today as the Second Boer War. Boer is the Dutch word for farmer, and the Boers originated from Dutch, Flemish, German, and French settlers. Some Boers even originated from British settlers who felt they didn't belong to the British Empire in a similar way as when the settlers in US decided to not anymore be a part of the British Empire. Because of the conflict across the Atlantic Ocean, Britain lost the American Revolutionary War and US became an independent nation. The Brits were now determined not to lose control of their colony in southern Africa.

One of the historical figures Elon admires is Winston Churchill. During the Second Boer War, the soon to be British prime minister worked as a war correspondent for *The Morning Post*. Churchill, who used to be an army officer, had resigned from the army to pursue a political career. But when he heard of the conflict in Africa, he couldn't resist to be a part of it.[11,79]

Churchill arrived to the conflict zone. Controlling the railroads was important during the war, so British armored trains patrolled the main routes. As Churchill traveled with one of these trains, the Boers lay in ambush. "I

have had, in the last four years, the advantage, if it be an advantage, of many strange and varied experiences, from which the student of realities might draw profit and instruction," Churchill wrote. "But nothing was so thrilling as this: to wait and struggle among these clanging, rending iron boxes, with the repeated explosions of the shells and the artillery, the noise of the projectiles striking the cars, the hiss as they passed in the air, the grunting and puffing of the engine – poor, tortured thing, hammered by at least a dozen shells, any one of which, by penetrating the boiler, might have made an end of all – the expectation of destruction as a matter of course, the realization of powerlessness, and the alternations of hope and despair – all this for seventy minutes by the clock with only four inches of twisted iron work to make the difference between danger, captivity, and shame on the one hand – safety, freedom, and triumph on the other."[11]

Despite that Churchill worked as an unarmed civilian reporter, the Boers captured him as a prisoner of war. Together with the British soldiers who survived the ambush, he was sent to the capital of the Boers: Pretoria. When he arrived, he became a prisoner in a school building temporarily converted to prison for officers. The name of the school was Staats Model School.

After the war ended, the two regions where the Boers lived became a part of the Union of South Africa. The victorious British renamed Staats Model School to Pretoria Boys High School.[77] Several years later, the same school would educate an aspiring space and vehicle entrepreneur.

Fourteen years after the peace, Elon's grandfather Walter Henry James Musk was born in Pretoria. He was the son of Harry Musk, who had married the seventeen year younger Lucy Frances Champion from Caledon, South Africa. They had six children.

The artisan Walter married Cora Amelia Robinson from England. They had two children: Errol Musk, born in 1946, and Michael Musk, born in 1952. Errol would become the father of a billionaire, but first he had to find a wife.

Elon's mother Maye Musk was born as Maye Haldeman. The Haldemans can be traced back to 1808 when Sarah Haldeman was born in Virginia, US. It's not known if she married, or if she lived with a man, but it's known that she in 1838 gave birth to John Haldeman.[97] The family had now moved west through the country to Bloomington, Illinois. This wasn't a

move without any risks - they moved to the undiscovered frontier of the American wilderness.

Euro-American settlers, who had arrived to the area in the 1820s because of the rich soil, established Bloominton in 1831. The town had eight stores, three groceries, two taverns, two lawyers, three physicians, a handsome academy building, two steam mills for sawing, and a population of 700.[86,92]

Before the settlers arrived, the native Indians of the Kickapoo people lived off the land. It turned out the settlers and the Indians couldn't live together. The Black Hawk War of 1832 took place in Illinois. It was a short war, only a few months long, between the US military and the Kickapoo people. One of the soldiers who fought in the war was a 23-year-old Abraham Lincoln.

After the war ended, the soon to be 16th President of the United States, Lincoln, visited Bloomington many times since he worked as a lawyer in nearby Springfield. It was in Bloomington Lincoln held a speech known as the "Lost Speech" because the reporters were so engaged by the speech they neglected to take notes.[86]

John Haldeman met his wife Evaline Haldeman in Bloomington. They had a son, John Elon Haldeman, born in 1872. In 1900, John Elon Haldeman married Almeda Jane Norman. They had two children: Joshua Norman Haldeman and Almeda Haldeman. The family had now moved to a log cabin in the small town Pequot Lakes, Minnesota.

Born prematurely, Almeda Jane Norman had to spend the first months of her life in an infant incubator. When she was growing up, she dreamed of going to high school, but her father didn't like the dream as he opposed the idea to educate girls. Almeda would later promote women's right to vote.[91]

A doctor diagnosed John Elon with diabetes and gave him six months to live. He went to a chiropractor to find a cure, and he recovered sufficiently to carry on with his normal daily routines for several years until he passed away in 1909. To look after her husband, the nurse-schoolteacher Almeda began studying to become a chiropractor herself. In 1905, she graduated from the Chiropractic School & Cure in Minneapolis.[91,93]

In 1907, the Haldeman family moved to Herbert, Canada. It's town in a region that at the same time can be haunted by a flood, a grass fire, and a snowstorm. The reason they moved was that they believed that if you have diabetes, you must live in a cold, dry climate.[88] Almeda worked as a

chiropractor and was most likely the first one in Canada with this profession. The family also started up a small restaurant and a boarding house.[91]

With inspiration from his mother, Joshua decided to become a chiropractor. Chiropractors had previously treated him after an accident while playing a game of shinny, which is similar to ice hockey. He played it on a frozen pond, and during the game, he received a blow to his head. After the accident, Joshua had a failing eyesight, but recovered after a visit to the Palmer School of Chiropractic.[91] In 1926, Joshua graduated after four years of studies, and he received the degree Doctor of Chiropractic. Throughout his life, Joshua studied at nine different universities and colleges if postgraduate programs are included.[95]

Joshua married Eve Peters in 1927, and their son Joshua Jerry Noel Haldeman was born seven years later. But the Great Depression of the late 1920s hit the family hard. They lost their farm because they were unable to maintain payments on equipment purchased on credit. Because of these events, Joshua became suspicious of financial institutions, which lasted throughout his life. Another result of these events was that the couple separated. But Joshua clenched his fists and endured life. His favorite quote became: “If you always enjoy everything you do, you will never do anything that you don’t enjoy.”[95]

Without the farm, Joshua began working with various jobs across the country. He worked as a construction worker, as a cowboy, and as a rodeo performer. While working at these jobs, he mastered skills such as boxing, wrestling, exhibition rope spinning, and pistol shooting. A biographical note described his life during the Great Depression:

> “He has traveled extensively in Canada; and during the depression by freight and passenger coal tender from Vancouver to Halifax. He has lived with the homesteaders in the bush country, trappers in the lower Peace River, farmed in the heart of the dust bowl when it was 100 percent on relief, been a stowaway on an ocean-going boat, and lived in the hobo jungles outside of most of the cities in Canada.”[95]

Joshua moved across the country to Regina, where he began working as a chiropractor. One day, Joshua decided to take lessons to improve his dancing skills. “Life seemed to be a little dull, so I decided to take dancing

lessons and phoned the local dance studio," he said. "The dance teacher said she was booked up until nine o'clock that evening. I told her, 'That's all right. I want to get started and will come back at nine o'clock.'" His dance teacher's name was Winnifred "Wyn" Fletcher from Moose Jaw, Canada.[95]

Six months passed since the first dance lesson. "When will you marry me?" Joshua asked Wyn. "Tomorrow," Wyn replied without hesitation. Because of the poor financial conditions, Joshua and Wyn's honeymoon destination was a straw patch on Joshua's parents farm. After the honeymoon, they moved to a small trailer owned by Wyn.[95]

The couple had five children: Scott, Edith Lynne, the twin-sisters Winnifred Maye and Almeda Kaye, and Angkor Lee.[95] They couldn't afford a proper bed, so Scott had to sleep in an old apple box. But as the chiropractor business grew, the family moved to a house with three floors and 20 rooms.[94]

Joshua was a competent chiropractor with many satisfied customers. "He used the x-ray to determine exactly where the problem was and then proceeded to give the correct adjustments," a co-worker said. "The results were very good – sometimes almost miraculous." Like a future space entrepreneur, Joshua showed a high work ethic. He could work in the evenings, on the weekends, and if the customers could not come to him because they were in great pain, he could treat them where they lived.[93] If they lived far away, he could fly to see them with his own aircraft.

Both Joshua and Wyn enjoyed flying in their single-engine aircraft nicknamed *Winnie*. Designed by the Italian Mario Bellanca, his aircraft were known for their efficient, low-operating costs, and they set many records in endurance and long-distance flights. Joshua himself set many of these records.[93]

The Haldeman family needed to fly so they could visit all the conventions and activities that interested them. In total, the Haldemans flew across 80 countries and territories. When Scott was just a baby, they brought him with them on their flying endeavors. Wrapped in a blanket, they placed Scott on the shelf behind their heads. The other siblings also got to go with them. "When they [Maye and Kaye] were three months old, we flew with them to Davenport, Iowa, to attend the Palmer Chiropractic Lyceum," Joshua said. "Pictures of the 'Flying Twins' were in the Davenport papers in the one

week. At a year old, the flying twins were certainly cute and attracted a lot of attention."[93,95]

When Joshua grew up, his mother Almeda allowed no one in her house to drink, smoke, use improper language, or tell shady stories. Playing cards and medicines were also prohibited.[91] Similar rules were established when Joshua became a father.

Joshua believed the body had the innate ability to heal itself if it wasn't abused and if it received chiropractic adjustments on a regular basis. His mantra was: *Haldemans don't get sick or upset*.[93] "He [Joshua] was a very strong chiropractor and believed in the old time chiropractic thing," Scott said. "If you had stayed healthy, you ate well, you drank well, you don't smoke, you don't drink, you exercise regularly, and you get your chiropractic adjustments periodically, that you'd live a long and happy life." Scott recalled that no one in the family ever visited a medical doctor or took any medication, and chiropractic adjustments were given to the family members for any symptoms.[88]

Forbidden activities in the family were smoking, swearing, and having headaches. It was also forbidden to be unhappy, pessimistic, or dishonest. The children were not allowed to drink coffee until they graduated from school, or drink alcohol until age 21. Joshua also collected ground wheat directly from local farmers to avoid unnecessary contamination, and during both the winter and the summer, he took a swim each day.[94]

In 1950, the entire Haldeman family, including *Winnie* the plane and a Cadillac, moved to South Africa. The reason why they decided to leave Canada is unclear. Joshua had never visited the country before, but he left a number of clues.[88]

The decision to move could have been based on political protests. Joshua was active in the political landscape in Canada and had once ended up in jail because of his political views. He thought the political system had deteriorated because of a rapid growth in the power of the government to control the citizens. He also thought the moral standards of the country had been lowered. Other reasons why they decided to leave Canada might have been a desire for an adventure, or a hope to advance the chiropractic science in another country.[93]

Yet another reason why they decided to leave might have been that Joshua opposed the use of cocaine in Coca-Cola. No one in the family was ever allowed to drink Coca-Cola, probably because Joshua had a friend who drank 20 bottles per day. His friend deteriorated mentally and physically before he committed suicide. This was not a popular view, so the family received several death threats. Joshua believed representatives from Coca-Cola delivered the threats. Another supporter of the campaign against the use of cocaine had mysteriously fallen out of a window. The police said he had committed suicide, but Joshua didn't believe them. Because of these threats, they may have felt they didn't have any other choice than to escape from Canada.[95]

With a freighter, it took the family 30 days to travel to Cape Town, South Africa – the same city as had resupplied the ships from the Dutch East India Company. The family had no plans for what to do when they arrived. To find a nice place to live, Joshua began flying across the country.[88]

One of the cities he flew over was the largest city in South Africa: Johannesburg. Winston Churchill described the surroundings when he approached Johannesburg from the south together with the British army. "We had marched nearly 500 miles through a country which, though full of promise, seemed to European eyes desolate and wild," he wrote. "At first, after we had crossed the Vaal [river], the surface of the country was smooth and grassy, but as the column advanced northwards the ground became broken – at once more dangerous and picturesque. Dim blue hills rose up on the horizon, the rolling swells of pasture grew sharper and less even, patches of wood or scrub interrupted the level lines of the plain, and polished rocks of conglomerate or auriferous quartz showed through the grass, like the bones beneath the skin of the cavalry horse. We were approaching the Rand [the ridge upon which Johannesburg is built]."[12]

Just outside of Johannesburg, there's a city called Pretoria. Once a year, Pretoria becomes distinctive from the surrounding landscape. The city is also known as the Jacaranda City due to the thousands of jacaranda trees planted in the streets, parks, and gardens. When Joshua flew above Pretoria, he saw all the jacaranda trees's blue and purple flowers and decided this was the place to build a new life and open a chiropractor clinic.[88]

Opening a chiropractor clinic in South Africa wasn't easy because most people had never before heard of chiropractors. They couldn't advertise because the Afrikaans-English dictionary didn't include the word

chiropractor, so they had to use their own personal contacts. “I was unable to get an office downtown, so bought a place 2.5 miles [4 km] from the business district,” Joshua wrote in a letter. “We moved in on the first of December and started to practice that day. Had good success with the first patients so the practice built up to 25 appointments by the 15th of January and 37 by the 5th of February, without any newspaper announcements or advertising other than personal contact and booklets.”[93]

Pretoria had a population of 270 000, and only two other chiropractors worked in the area. The clinic founded by Joshua became one of the largest clinics in the entire South Africa. As many as 175 patients could be treated each day. Their customers included one of South Africa’s presidents and several ministers.[93,95]

The adventurous flying continued after the family moved to Africa. Joshua piloted *Winnie* the plane on a trip around Africa, and another trip up to Norway and Scotland. Using only a compass to navigate, Joshua made a 30 000 mile [48 000 km] journey up the coast of Africa, across the Asian coast to Australia, around Australia, and back to South Africa. He’s considered to be the only private pilot to have made such a trip in a single-engine aircraft.[95] Sometimes when he stopped on the way to refuel the plane, he had to rebuild the engine before he could begin the refueling process. At some airfields he could only fill up *Winnie* with diesel, and at other airfields, he had to fill up the plane with gasoline.[4]

Another adventure took place when Joshua and Wyn participated in the 8 000 mile [13 000 km] *Algiers to Cape Town Rally*, now renamed to *London to Cape Town World Cup Rally*. The rally is considered the most grueling motor race in the world. It didn’t stop the Haldemans and the couple tied first place with their Ford station wagon.[88] At first it might seem strange, but they had earlier practiced desert driving when they searched for ancient ruins.

The Great Farini was the stage name of the entertainer William Leonard Hunt, who had realized he wanted to become an acrobat when he sneaked into a circus. One of his acrobatic acts included walking across the Niagara Falls on a rope. Farini moved to London where he became a celebrated acrobat. But he feared that if he continued, he would sooner or later be seriously injured, so he decided to change career. He remained within show business as an inventor with 100 patents, including a now famous apparatus known as the human cannonball.[89]

One of the most successful shows Farini worked with was *African Pygmies*, which included six live Bushman from Africa. From their interpreter he learned of a legend that said there's a lost city in the Kalahari desert with diamonds in abundance. Farini traveled to Africa where he crossed the Kalahari Desert – a remote and inhospitable place in the southern parts of the continent. When he returned, he claimed he had discovered the ruins of an advanced civilization: the Lost City of the Kalahari Desert. In 1885, Farini described the ruins as:[73]

> A half-buried ruin – a huge wreck of stones on a lone and desolate spot; a temple – or a tomb for human bones left by men to decay and rot.
>
> Rude sculptured blocks from the red sand project, and shapeless uncouth stones appear, some great man's ashes designed to protect, buried many a thousand year.
>
> A relic, may be, of a glorious past, a city once grand and sublime, destroyed by earthquake, defaced by the blast, swept away by the hand of time.

It's unclear when Joshua found out about the Lost City of the Kalahari Desert, or why he became interested in finding it, but he did everything he could to find it. He and his family made several expeditions through and above the desert.[90]

The expeditions covered large areas, and Joshua participated in sixteen expeditions. "We flew 8 400 miles [13 500 km] altogether in our aerial search, most of it at 200 feet [61 m] and 300 feet, and sometimes down between the peaks of the sand-dunes," he said. "There are possibly a hundred prominent sand-dunes in the area. We have even seen ostrich eggs on the ground – but on the other hand we had to make three passes before all three of us in the plane could spot a ten-foot animal hole in the side of a sand-dune."[73]

They didn't always fly on the expeditions - they could also use trucks and Willy's Jeeps from the Second World War. There were no roads through the desert, so they had to use a compass to navigate.[90]

With them on these expeditions, Joshua and Wyn often brought the children. The smallest children had to sleep in the larger trucks to avoid the

risk of being eaten by a wild predator during the night. “We had lions in the camp so close my father could almost touch them,” Scott said. “The camps were often surrounded by hyenas, jackals and leopards that would keep the air full of wild sounds. I carried a pistol on my hip most of the time to protect against animals and would often have to ride on top of the truck with a 375 mm Winchester rifle hoping that the truck would flush a buck and I could get in a shot.”[90]

A saying in the desert is that there’s no such thing as an intruder. Anyone who shows up is somehow expected. On one occasion, when they had heard a dangerous predator growling, Wyn had to spend the night by guarding the camp armed with a pistol. Wyn shared Joshua’s interest in pistol shooting and became a South African women’s pistol champion. “Scott and I were too sleepy to stay awake, but felt perfectly safe with such a good camp guard,” Joshua said. “She can shoot faster and more accurately than either of us.” When they woke up the next morning, they found traces from leopards close to the camp.[90]

Each expedition through the desert could take up to one month. To avoid living on canned food during the entire trips, they hunted animals. Joshua shot a buck, and the twin-sisters had to take skin off the animal. They didn’t like the task, so they often cried as they felt sorry for the dead deer. But it didn’t stop them from eating the cooked stew with great appetite.[80] They always killed animals to eat – never for pleasure. “Dad never allowed hunting for hunting’s sake although on one occasion we had to help out a village and hunt a lion that was killing the village goats as he was old and could not hunt wild animals,” Scott said.[90]

These adventures through and above the desert ended in 1974 when Joshua died in an air crash accident in South Africa. Joshua was always convinced the Lost City of the Kalahari Desert existed somewhere out there. “Some who have flown a small fraction of the time and distance we did are positive that the ruins cannot exist because they did not see them,” he said. “We feel that we could quite possibly have missed them in the camouflaged desert terrain, even if they were still visible. But there is the possibility that the ruins are completely covered. As the sand-dunes are not so big, there should still be some evidence of a wall that Farini could follow for a mile or even one-eighth of a mile. His story and his description of the country ring true. Perhaps someone will have to dig, but some day the Lost City of the Kalahari will be found.”[73] Farini himself died of influenza in 1929, so Joshua

wrote a letter to Farini's relatives. "We do not feel he made the Lost City up as we have confirmed everything else in the book."[90]

Recent research revealed that Farini didn't find any ruins. The most likely scenario is that he found a rock formation that could resemble the ruins of a city buried in the desert. On the other hand, everyone thought the city of Troy was a myth until Heinrich Schliemann discovered the ruins in 1873.[90] So still in the 21st century, explorers are searching for the Lost City of the Kalahari Desert, both through the air and on land.[74]

While Joshua flew above the desert, his daughter Maye grew up. She found her South African husband Errol Musk, who had begun to work as an electric and mechanical engineer. He ran his own construction engineering firm where he worked with both government and commercial projects.[4,51] Just after graduating, and just after their marriage, Maye was pregnant.[83] Named after his great grandfather John Elon Haldeman, Elon [pronounced ee-lon] Reeve Musk was born on a Monday, June 28, 1971.[357] The name Elon is Hebrew for oak tree, but the family were not Jews.[84,117] Elon had two siblings, Kimbal and Tosca, whom we shall meet again.

Boredom Leads to Great Things

Winston Churchill didn't like his life as a prisoner of war. One month after arriving to the prison in Pretoria, he climbed over the walls. "I had 75l [£75] in my pocket and four slabs of chocolate," Churchill said, "but the compass and the map which might have guided me, the opium tablets and meat lozenges which should have sustained me, were in my friend's pockets in the State [Staats] Model Schools."[11]

Because the compass and the map were still in the prison, Churchill navigated through the city by using only the stars. "The night was delicious," he said. "A cool breeze fanned on my face and a wild feeling of exhilaration took hold of me." No one suspected he was an escaped prisoner of war as he wore a hat and a brown, civilian suit.[11]

Churchill walked towards the railway, which he found. He followed it until a train station appeared where he waited until a train arrived. As the train began to move again after a brief stop at the station, he jumped aboard one of the wagons where he hid among soft sacks covered in coal dust. Before daylight, Churchill jumped off the train, and knocked on the door of the first house he saw at a distance in the night. "Thank God you have come here," the owner of the house said. "It is the only house for 20 miles [32 km] where you would not have been handed over. But we are all British here, and we will see you through." Churchill escaped to the neighboring country Mozambique, and the achievement to escape from the prison made him a national hero in Britain.[11]

Another prisoner in Pretoria was the six-year-old Elon Musk. For an unknown reason, he had been grounded and thus prevented to visit a birthday party at his cousins's house. He disagreed with the decision to ground him and felt it was an unjust decision, so he planned to escape and visit the party anyway.[363]

The first idea Elon had was to take his own bike, and he told it to his mother Maye. She decided to lie by saying that Elon needed a license for his bike or the police would stop him. He wasn't sure if his mother had told him

the truth. To be on the safe side, Elon decided to walk the ten miles [sixteen km] to the party.

He sneaked out of the house and began walking across Pretoria in a similar way as Churchill when he had escaped from his prison. While Churchill navigated by the stars to find his way through the city, Elon who had just learned how to read, navigated by reading the road signs to find out in which direction he should go.[326] Due to Pretoria's British heritage, he passed the many colonial buildings and the double-decked buses driving on the left side of the road.

The stroll across Pretoria took four hours. Just before Elon arrived to the party, Maye saw him walking along the sidewalk and he saw her. Maye had earlier arrived to the house to leave Elon's siblings Kimbal and Tosca who were allowed to visit the party. Elon decided retreat was the best option. With the speed of a dog chased by a cat, he climbed a tree where he stayed until his mother promised she wouldn't give him a punishment. He came down and returned home where he continued to be bored as so many times before.

Elon became bored easily. Since he didn't have many friends, the options he had at the time were to either play with his siblings, read books, or watch television. Elon described the television shows in South Africa as horrible. He didn't like watching television shows like *CHiPs*, a series about two motorcycle police officers, and *Die Man van Intersek*, a dubbed version of the series *Gemini Man*. What didn't bore him was to read books and comics.[56]

Elon could read almost everything he could find for up to ten hours per day. Sometimes he read two books a day.[51] When the family went for a walk, Elon disappeared into the nearest bookstore where he could sit on the floor in his own world. The booksellers had to chase him away when they got tired of him. While attending dinner parties with his mother, he often brought a book with him to read if the table neighbors were not interesting enough.[59]

The books he enjoyed most were about a hero who felt a duty to save the world and the books about adventurous explorers.[59] He read *The Lord of the Rings* by J.R.R. Tolkien, everything by Jules Verne, the *Foundation Series* by Isaac Asimov, and everything by Robert Heinlein, including *The Moon Is a Harsh Mistress* and *Stranger in a Strange Land*.[126] While reading the books by Jules Verne, Elon became interested in physics. He could read them several times. "I was completely mesmerized by how Verne presented

glimpses into the future, and envisioning things, such as submarines, spaceships, and space voyages, ahead of their times," Elon said.[62]

Many years later, his favorite books would include the biography on Benjamin Franklin and the biography on Steve Jobs – both written by Walter Isaacson. He especially enjoyed Franklin's entrepreneurial spirit.[324]

Elon read all the comics available, from *Batman* to *Iron Man*, from *Superman* to *Green Lantern*.[324] Little did he know that when *Iron Man* became a movie in 2008, Elon himself was the inspiration for the movie version of the comic's superhero Tony Stark.

When Elon ran out of books and comics to read, he began reading encyclopedias, and he read the entire *Encyclopedia Britannica*. Maye recalled how her son remembered large parts of the encyclopedia after finishing it.[117] His sister Tosca gave him the nickname "genius boy" because she thought her brother was a genius who could remember everything.[327]

Because he read so much, Elon gained knowledge other children around him didn't have. One story took place outside of his grandmother's house. Elon played together with his siblings in the garden. It was about to get dark, so everyone except Elon went inside the house. "Come on Elon. Let's go," they told him. But Elon refused to listen to them. He thought the night was beautiful. Tosca said, what everyone except Elon thought, that the dark scared her. But Elon didn't remain outside in the dark garden to be mean. He wanted to teach them something. "Don't be scared of the darkness," he said. "There is nothing to fear – it is merely the absence of light."[49]

Elon's schoolteachers described him as quiet and unassuming. He was brilliant at math and science, and in love with his computer.[290] Since Elon was ambitious and a fast learner, he often criticized the other children when they were wrong, and he corrected their minor factual errors. "Cause if you don't have your health, you don't have nuthin," Elon was told. "Well, no. You do have a few things," he replied.[160] When the siblings discussed the Moon, one of them said, "Look at the Moon; it's a billion miles away." Elon knew the Moon wasn't that far away. "Actually, it is 384 400 kilometers away," Elon replied proudly. Everyone else was silent. "On average," he continued.[49]

He didn't correct other people because he wanted to prove he was more intelligent than anyone else. He wanted to help them. His classmates didn't always understand this help. They thought Elon was arrogant, and responded

by bullying him. They called him “smarty pants” and said he looked like a muskrat, which is a larger rodent looking like a large fluffy rat.[59] That he was the shortest one didn’t help either – he had begun school a year early. “I would say I was less happy than most kids,” Elon said. “I didn’t develop any friendships. If you’re the small bookworm you get the crap beaten out of you.”[4]

Elon recalled that his two options to get away from his tormentors were to either run or hide. He often hid in the school library where he read books. “I would see him frequently in or around the library,” one of his teachers said.[450]

Steve Jobs suffered the same fate when he skipped one grade. He was also a socially awkward loner who was often bullied. Jobs solved the problem by changing school to the best his family could find. It’s unclear why Elon didn’t change school, maybe he couldn’t? “It’s pretty rough in South Africa,” Elon’s siblings said. “It’s a rough culture. Imagine rough – well, it’s rougher than that. Kids gave Elon a very hard time, and it had a huge impact on his life. In South Africa, if you’re getting bullied, you still have to go to school. You just have to get up in the morning and go. He hated it so much.”[278]

Elon was often in a world of his own. “We’ll all be out to dinner with him,” Maye said, “and someone will say, ‘Let’s see a movie after dinner. Elon what movie do you want to see? Elon? We’re talking about a movie.’ But Elon’s not eating. He’s just sitting there. Thinking. ‘Okay, Elon’s not with us for a while, we’ve got to let him be wherever he is. Let’s, the rest of us, talk about the movie.”[49]

It went so far Elon’s family thought it was something wrong with him. “His brain was just ahead of everyone else’s and we thought he was deaf, so we took him to the doctor,” Maye said. “But he was just in his own world.” The doctors took out Elon’s adenoids, but it didn’t change anything. “It’s just when I’m concentrating on something I tune everything else out,” Elon said.[50]

Elon has always wanted to find out the facts. He has always wanted the reality, so he never made things up and has never had any imaginary friends.[49] If his parents told him something, Elon always asked “Why?” When his parents told him the answer, he compared it with what he already knew. If the answer and his knowledge didn’t match each other, he asked

“Why?” again. And so it went on until either Elon was happy or his parents gave up.[354]

But sometimes he forgot to look up the facts. Elon and his one-year younger brother Kimbal decided to make a 50 miles [80 km] long bike trip from Pretoria to Johannesburg. Thinking they could find their way through the country without any problems, neither of them had a map. They were wrong. Halfway through the trip, they were lost. This was at a time when the South African government had established the apartheid system, so it was not safe for two white boys to bike through dangerous neighborhoods controlled by enraged people who had been discriminated.[51]

The word apartheid is Afrikaans and can be translated to separateness. European settlers had always suppressed the natives. In 1910, the Union of South Africa was established and the new government made whites the supreme power. Blacks were forced to live in poor overcrowded townships.[187]

When the National Party took over the power in 1948, they extended the segregation. The Prohibition of Mixed Marriages Act of 1949 prevented whites from marrying someone with another race. No blacks were allowed to vote or own any property, and they had to carry with them a special passport. If they didn’t, they were jailed. In 1960, a large crowd of black protesters decided to not show their passports. “The police can’t arrest everyone!” They were wrong. Outside of the police station in Sharpville, the police opened fire. 69 people were killed. The South African government declared a state of emergency, and arrested more than 18 000 people.

Marjorie Madikoto grew up in South Africa at the same time as Elon, and she was exposed to the discrimination. “We rode different buses if we went to town,” she said. “You need to go to the bathroom; you went to a different bathroom. There was a park for white people, a park for black people. The park for black people didn’t have anything else, not even benches or anything. Then when they made them [the parks for black people], white people complained because they wanted to be everywhere. We could only buy [groceries] from a window and only white people could enter the store.”[187]

Not only black people were discriminated. The Indian Mahatma Gandhi was 24 when he arrived to South Africa. Gandhi bought a first-class ticket to travel by train to Pretoria. While on the train, a white European entered his compartment and began complaining that non-whites were not allowed in

first-class compartments. But Gandhi refused to change compartment, so they pushed him out of the train. He had to spend the night at the train station. “It was winter, the cold was extremely bitter,” Gandhi said. “My over-coat was in my luggage, but I did not dare to ask for it lest I should be insulted again, so I sat and shivered.”[251]

Pretoria became apartheid’s model city. Before the 1950s, there were roughly equal numbers of whites and blacks living in and around Pretoria. They were still segregated, but lived close together around the city center. But after the 1950s, thousands of residents were forced to move. The city would consist of three areas where each area was separated from the other by considerable distances, agricultural land, and political boundaries.[78]

The Musk family didn’t support the apartheid system. Kimbal said it was surreal to grow up in South Africa at the same time as all these extraordinary events occurred.[327] Like most white people in South Africa, they knew apartheid was wrong, but they couldn’t do much about it. If you spoke out against apartheid, you could be thrown into prison for three years.

As Elon grew up, he began to wonder what he wanted to do with his life. “When I was young, I didn’t really know what I was going to do when I got older,” he said. “People kept asking me. Eventually, I thought the idea of inventing things would be really cool. The reason I thought that was because I read a quote from Arthur C. Clark, ‘A sufficiently advanced technology is indistinguishable from magic.’ That’s really true.” Many years later, Elon held a speech. “Engineers are the magicians of the 21st century, don’t let anything hold you back. Imagination is the limit,” he said.[63]

An engineer can perform the same acts as magicians, but the acts by the engineers are no illusions. While a magician can convince an audience it’s possible to fly by creating an illusion, an engineer can build an aircraft making it really possible to fly. “If you go back a few hundred years, what we take for granted today would seem like magic – being able to talk to people over long distances, to transmit images, flying, accessing vast amounts of data like an oracle,” Elon said. “These are all things that would have been considered magic a few hundred years ago.”[117]

With inspiration from the quote by Arthur C. Clark, Elon performed a series of magical experiments. Attempting to hypnotize his siblings was the first experiment. “He wasn’t very good at it. I’d be like, ‘No, Elon, I’m not

going to eat raw bacon.' But he kept on trying," Tosca said.[278] Elon also showed some magical entrepreneurial skills by experimenting with business ideas. He, his siblings, and their cousins sold Easter eggs in the neighborhood, and they sold homemade chocolate to their classmates.[51]

Other magical experiments consisted of homemade, potentially lethal, explosives and rockets. "It is remarkable how many things you can explode," Elon said. "I'm lucky I have all my fingers." He had to build everything from scratch because it was impossible to find hobby rockets in South Africa. To find rocket fuel, he visited a chemist to buy the ingredients needed.[56] "I had always been interested in space, from the time I was a kid looking at the stars in South Africa," Elon said. "I was inspired by the Apollo astronauts and wanted to one day set foot on the Moon or even Mars."[51,60,62]

The Apollo program was NASA's third human spaceflight program with the goal of landing a man on the Moon and returning him safely to the Earth by the end of the 1960s. Neil Armstrong and his crew achieved this goal in 1969 when he became the first person to walk on the Moon. The other human spaceflight programs were called Mercury and Gemini.

You could suspect Elon found his technical spirit from his father who was an engineer, but that's not true. He was exposed to technical subjects while growing up, but his father wasn't a technologist. His grandfather, who could rebuild engines and fly around the world, was a smaller source of inspiration. But the largest role model was Thomas Edison. Many years later, the list of Elon's personal heroes would include Steve Jobs, Bill Gates, Henry Ford, and Walt Disney.[354] They were all creative people who had taken risks, defied failure, and bet their career on doing things in a different way.

"Picasso had a saying - 'good artists copy, great artists steal' - and we have always been shameless about stealing great ideas," Steve Jobs said. Also Edison stole some ideas from Nikola Tesla, who worked as an inventor at the same time as Edison.[323] Despite the accusations against Edison, Elon explained he's a larger fan of Edison than Tesla. While Edison brought "his" inventions to the market and made them accessible to the world, Tesla kept them in his head. Edison always hired assistants to realize his inventions, and he liked to say he could tell the importance of one of his inventions by the number of dollars it brought in and nothing else concerned him.[354]

At age ten, Elon bought his own computer with money from his allowance he had in a savings account. He also got a financial contribution

from his father to afford the first computer to sell over one million units: the Commodore VIC-20. “I thought it was like the most awesome thing I’ve ever seen,” Elon said.[324] He had earlier used the less advanced Atari computer.[258]

The computer created a new type of world where Elon could sit in a world of his own. “Every man and woman should play the noblest games and be of another mind from what they are at present,” the Greek philosopher, Plato, said. Playing a game is a way to live a dream. You are only judged by your performance – not by your sex, origin, or appearance. And Elon loved to play games on his computer.

Before it became common to have computers in the home, the gamers flocked to the arcades, where they played games like *Space Invaders*, *Asteroids*, *Donkey Kong*, and *Pac-Man*. In Japan, they suffered a shortage of hundred-yen coins because they were stuck in the arcade machines or in the pockets of the fanatic players. “I don’t drink, I don’t smoke, I don’t do drugs. I play video games which I think is a far superior addiction than any of those other ones,” an arcade gamer said. “Those games challenged eye-hand coordination, mind-body coordination, fast reaction time, comprehensive thinking, on a level that modern games don’t.”[369]

Elon, who liked these arcade games, tried to start his own arcade company together with his brother. “It was a very compelling proposition when you’re thirteen and you love video games,” Elon said.[71] They found a building, they contacted a supplier of arcade games, and all they needed to open their dream was a permit from the city. But to get a permit, one of their parents had to sign a document, and neither of their parents thought it was a good idea. “We got stopped by the city,” Kimbal said. “We couldn’t get a variance. Our parents had no idea. They flipped out when they found out, especially my father.”[278]

When home computers became affordable, the arcade era ended. The gamers could now create their own games. Elon felt he needed to learn how to program his own computer software because he wanted to learn how to create his own games. He asked his father if he could teach him how to program, but Errol thought computers were only toys that will amount to nothing and he refused to use computers. Elon thought his father was silly, so he decided to learn how to make his own games despite his father’s negative thoughts.[49]

To learn how to make his own games, Elon attended classes in computer programming. But he was always ahead of the teacher. Bored, he began to

teach himself how to program with the help of the thick, heavy manuals that arrived with early computers. He became a better and better programmer and in the end, he could really make his own computer games.

In 1983, at age twelve, Elon earned $500 when he sold a game he had made to a computer magazine. “I read a lot of computer magazines and there was a computer magazine that you could sell software to,” Elon said. “I needed more money to buy a better computer and more video games. So I mailed it in and they bought it. They didn’t know I was twelve years old.”[451]

It seems probable the name of his game was *Blastar*, though some sources said it was *Blast Star* and some said it was *Blaster*. The game was a combination of the popular arcade games *Asteroids* and *Space Invaders*.[20] “In this game you have to destroy an alien space freighter, which is carrying deadly Hydrogen Bombs and Status Beam Machines,” the description said.[327] Whatever the name of the game was, don’t confuse it with the game *Blastar*, released by Core Design in 1993. Elon would later sell another computer game to the same magazine.

Maye and Errol divorced when Elon was nine years old, and the siblings began living mostly with their mother.[4] “By my late twenties, my marriage had deteriorated so badly that every day was miserable,” Maye said. “I had all my confidence driven out of me. I began buying and reading self-help books. These inspired me to make a change. So, with my children, I left my marriage in search of a better life. Once this had happened, I felt as if a dark cloud had been lifted and there was hope. The changes were scary and risky: a new city, a new business and no self-confidence. But slowly, I grew stronger and became much happier.”[82] After the divorce, Maye and the siblings moved to live in Durban and Johannesburg. Elon and his father have only been in limited touch since the divorce.[324]

The divorce between his parents may have increased Elon’s ability to handle chaos, stress, and uncertainty. The Stanford professor, Steve Blank, argued that a disproportionate number of entrepreneurs grew up in dysfunctional families.[112] Starting a company is a chaotic and stressful process. “Starting a company is like eating glass and staring into the abyss of death,” is a quote often used by Elon, but the quote originates from his friend Bill Lee. “Staring into the abyss of death” means the entrepreneur is constantly facing the company’s extermination because 90 percent of all new

companies fail. “Eating glass” means the entrepreneur has to work with the problems benefiting the company most – not the most fun problems.[353]

Most white people in South Africa had maids and servants. But the Musk family didn’t because Errol made the family play a game called “America.” When they played it, the children had to do every chore Errol thought an American child did, including cleaning the house and mowing the lawn. “My father was very strict,” Tosca said. “I guess I was a bit of an autocratic father - do this, do that,” Errol replied. “I was a single parent, and they simply had to help out.”

When they didn’t play America, Errol brought the children on annual trips around the country. Once, Elon got to fly with him in his twin-prop plane to an emerald mine in Zambia in which Errol owned a share. They filled the plane with chocolate bars intended as a bribe for the customs agents.[278,450]

At age eleven, Elon wanted to move to the US. He had visited the country before together with his father. America meant freedom, and freedom to the young Elon meant movies, technology, and comics. “I have to admit I might have been a bit too fascinated about America, but it really did seem everything was possible there and, at the time, not so possible in South Africa,” he said. Elon obviously couldn’t move on his own, so his plan was to convince his father to move with him. All three siblings lived with their mother, and Elon thought it was unfair that no one lived with their father.[59,60] Errol said yes. Then he changed his mind because he felt he had established himself as an engineer in South Africa, so he didn’t want to restart in another country.[363]

As Elon grew older, there were still no signs of weaknesses in the apartheid system. He knew the government would force him to serve the two years of compulsory military service for white men. Joining the military wasn’t an issue. What he didn’t want was to participate in the suppression of the black people, which is what the military did. “Who wants to serve in a fascist army?” Elon asked. To avoid joining the military, Elon had to revive the old plans to move to the US.[263]

Once again, Elon tried to convince either of his parents to emigrate across the Atlantic Ocean. His mother was born in Canada and her father was an American citizen. But because his mother hadn’t received her American citizenship at a certain age before her father died, Elon couldn’t get an American citizenship for himself. So he didn’t have any other option than

moving to Canada. His mother had a Canadian citizenship she could pass on to her son.[327]

As his grandfather Joshua once had, but in the opposite direction, Elon decided to move across the Atlantic Ocean. Just before his sixteenth birthday, Elon and his brother Kimbal took the bus to the Canadian embassy where they applied for passports. Kimbal also knew he wanted to leave South Africa before he had to join the military.[71]

Three weeks after the passport arrived, and despite that Elon's parents didn't want him to leave South Africa, he bought a one-way plane ticket to Montreal, Canada.[128] He financed the plane ticket by selling shares in a pharmaceutical company. One year earlier, Elon had begun speculating in stocks; tracking them in the local newspaper.[4] He had tripled his money before he got bored of it.[258]

Elon was now ready for a new adventure. "We humans are explorers by nature, that's why we've ventured to the bottom of the oceans and the top of the tallest mountains," he said. "That's also why we have sent men to the Moon and astronauts to live on the orbiting International Space Station. It was this innate desire for exploration that also motivated me to leave South Africa."[62]

What Do I Do Now?

In 1989, Elon Musk took the first small step on Canadian soil. When he flew away from South Africa, his mother Maye was so proud her son had become independent. But while still at Montreal's airport, the first thing Elon did was to call his mother. "What do I do now?" he asked. Elon decided to take the bus from Montreal to Vancouver. It allowed him to see Canada from the highway while he could figure out where to go and what to do with his life in the new country.[327]

He traveled to the region where his mother lived before the family immigrated to South Africa. To find somewhere to sleep, he visited distant relatives that he never met before, and to support himself, he worked with various low-wage jobs. Elon's cousin owned a wheat farm in Swift Current, so he began working there. The work consisted of tending vegetables and shoveling grain. He then moved to a lumber mill in British Columbia where he cut logs and cleaned boilers. "You had to put on this hazmat suit [hazardous materials suit] and shimmy through this little tunnel," Elon said. "Then you take this steaming goop and shovel it back into the hole you just came through and wait for someone else to put it into a wheelbarrow."[51]

The savings account consisted of only a few thousand dollars. To be sure that the money lasted, Elon had to conserve his resources. He bought large quantities of oranges, pasta sauce, and sausages. Because of the large quantities, he had to eat the same food for a whole week. To get the necessary vitamins, he ate one orange a day. The rest of the day he ate hot dogs with bread from a loaf – not buns since they were too expensive.[350] "I tried various experiments to live on less than one dollar a day without getting scurvy," Elon said. "You can cook spaghetti sauce with, like, a third of a green pepper, or buy a thing of sausages and a loaf of bread to make hot dogs for 25 or 30 cents apiece."[307]

Someone who wasn't happy when Elon moved to Canada was his sister Tosca. She missed her genius brother and wanted to join him in Canada. Her mother Maye explained to her that Elon was eighteen years old and Tosca was fifteen years old, and that made it obvious she couldn't join her brother.

But Tosca refused to accept the answer. While Maye was away on a trip, Tosca came up with the brilliant idea to sell the family's house. If they didn't have a house to live in, they all would have to move to Canada. When Maye returned from the trip, Tosca had put the house on the market and sold it. "I think we must leave now," Tosca said. Maye wasn't convinced.[49]

Years later, Maye changed her mind, so Maye, Tosca, and Kimbal moved to Canada. Almost everyone else in the family would move away from South Africa. Elon's grandmother Wyn remained in South Africa, working with wood carving, pottery, and painting. In 1999, she also moved back to Canada together with her daughter Edith Lynne.[85] Like his father and grandmother, Scott became a chiropractor and would study and work both in Canada and in US.[94]

One year after arriving to Canada, and while working at the Bank of Nova Scotia, Elon applied to the prestigious Queen's University in Kingston.[55,61] The school was known for its high academic standard and wealthy students. It was common to hear comments like, "It took a long time to learn how to drive because my family was chauffeured everywhere." You could also order a latte in the cafe, which in the 1990s was exotic.

Before Elon applied to the university, he chose between if he should study at the University of Waterloo or at the Queen's University. "It was a close call for me between the University of Waterloo and Queen's," Elon said. "I was going to do physics and engineering at Waterloo, but then I visited the campus, but there didn't seem to be any girls there. So, I visited Queen's, and there were girls there. I didn't want to spend my undergraduate time with a bunch of dudes."[128]

Elon began to study business and physics, but he never attended the classes. The genius boy used his photographic memory, so he read the textbooks and showed up for the exams. He thought dating girls was much more interesting than studying. It was after all the sole reason why he picked the school.[327]

One of the girls he dated was Justine Wilson. One year younger than Elon, she grew up together with her sister in the small town Peterborough, Canada. Both her parents gave her a lot of space and freedom, and her outdoors-loving father said she had more or less raised herself.[139] Those who didn't know her thought she was European looking. After a journey through

Australia, she began studying at the Queen's University, and was now a first-year student.

Compared with Elon, Justine studied more than he did. She had to. To keep her scholarship for four years, she needed straight A average, and she often got panic attacks from the pressure. To ease the stress, she practiced for a black belt in taekwondo, wrote fiction in cafes, and drank vast amounts of coffee and inexpensive red wine. "Bless those tasty Australian shirazes, stay away from the cheap French stuff," she said.[153,157]

Elon saw Justine from across a room inside of the university. To begin talking to her, he lied by saying they had met before at a party. But Justine knew she had never attended this party, and she thought Elon was a clean-cut, upper-class boy with a South African accent. When Elon asked her out for an ice cream date, Justine decided to lie back by saying yes.[182]

The unsuspecting Elon went to Justine's room where there were supposed to meet each other. He walked up to the door where he found a note explaining the lie. But Elon didn't give up. He searched through the university and found Justine while she read a Spanish text in the student center. Carrying two ice creams, he surprised her. But Justine wasn't impressed and Elon had already decided to transfer to a university in another country.[182]

Canada wasn't exciting enough to Elon and he decided early on that he wanted to live where the really exciting breakthroughs happened: United States. "If you want to have a significant impact on the world, the United States is the best place to do that," he said.[316]

"I'm not suggesting that things couldn't be better," Elon said. "We should be asking ourselves, have we made the environment better or worse?"[316] He compared it with democracy. While democracy is the least bad government system, the US is least bad at encouraging innovation compared with other countries.[351] "However, if you look at new technology, it's crazy how much of it comes out of the United States," Elon said. "If you want to do cutting edge stuff, you come to the United States. It's not so much that there aren't great entrepreneurial opportunities in China and India, they are huge – especially for people who were born and raised there. But it's not cutting-edge technology. Name three things that came out of India or China in the last 200 years."[375]

Winston Churchill had a saying, “You can always count on Americans to do the right thing – after they’ve tried everything else.” The reason to why US is the country where you succeed is that US is open to new ideas. Then it becomes a self-fulfilling prophecy. US attracts people with new ideas because of its openness to new ideas and the acceptance of failure.[354] “If I had been born in some cave, I suppose I would still try to be innovative, but there would be limits,” Elon said. “You have to have the environment that encourages innovation as well. Let’s say I had been constrained to live in South Africa, where I was born. I would not have been able to achieve a fraction of what I have here.”[52]

Elon arrived to the US thanks to a scholarship and enrolled at the University of Pennsylvania, also known as Penn. While studying at Penn, Elon shared a house with Adeo Ressi, who was another Penn student as well as an outsider like Elon. “He was the biggest dork I’ve ever met,” Ressi said of Elon years later.

Ressi, the son of an engineer and a social worker, grew up in New York. During the summer, while other children went on summer camps, Ressi lived in the experimental city Arcosanti in the middle of the Arizona desert. The Italian architect, Paolo Soleri, had designed the city. He used a concept called arcology – a combination of architecture and ecology. “I had the opportunity to experience a very utopian vision of the world,” the youngest inhabitant in the city, Ressi, said. While at Penn, Ressi ran a newspaper with a focus on environmental issues: *The Green Times*. As his final thesis, he tried to submit this newspaper, but his thesis professor didn’t accept it, so he never got a degree.[46]

When Elon and Ressi first met, they lived in a giant campus dorm. But they didn’t like the environment, so they decided to rent a large house outside of the campus area. “We were both transfer students and they stuck us in these giant dorms and we just wanted to get out,” Ressi said.[60] They would later move to an even larger house with fourteen rooms. Spent kegs with plywood on top became cheap furniture.

Only three of them lived in the larger house.[47] The third person is unknown, but Elon and Ressi recalled they had forever changed this person’s life. It’s unknown if it was for better or worse.[349] At one point, Elon’s mother felt a need to check on him to see if he had enough food to eat, and she also made sure he wore a fresh pair of socks each day.[117]

"We weren't connected to the fraternity scene, and we weren't new students either," Ressi said. "We had to meet people, so we decided to have parties, but since we also didn't have money, we decided to make it a business." While Ressi transformed their house into a club, Elon took care of the finances. Elon was the sober one who had to talk to the police when they arrived for unknown reasons. To take care of the guests, they hired bouncers, and to clean up, they hired a cleaning crew.[60] Up to 500 guests could attend these wild parties. The guests had to pay five dollars each to drink as many beers as they wanted, but the profit each night could still be as high as a thousand dollars.[47]

While not hosting parties, Elon played first-person shooter games on his computer. It's unclear how much he studied and how much he played games, but Elon explained he earned a bachelor's degree in physics and economics with an unofficial minor in first-person shooter games.

Elon earned two degrees: a degree in finance from the Wharton School and a degree in physics from the University of Pennsylvania.[262] He already knew he wanted to create something big, so he didn't have any other choice than to get two degrees. "I studied physics and business, because in order to do these things you need to know how the universe works and how the economy works and you also need to be able to bring people together to create something," he said. "It's very difficult to create something as individuals if it's a significant technology."[63]

As an engineer before anything else, Elon thought the undergraduate business degree was easy. All business courses combined during the final year were not as difficult as one course in quantum mechanics from the degree in physics.[350] But he would never regret the decision to also get a degree in finance. "I'm head engineer and chief designer as well as CEO, so I don't have to cave to some money guy," Elon said. "I encounter CEOs who don't know the details of their technology and that's ridiculous to me."[50]

While not studying, playing games, or hosting parties, Elon worked. He wrote business plans for an electronic book scanning service, and he worked two summers for an ultracapacitor energy storage venture called Pinnacle Research.[51]

Elon also worked for the video game developer Rocket Science Games.[71] He participated in the development of the games *Loadstar: The Legend of Tully Bodine*, released in 1994, and *Cadillacs and Dinosaurs: The*

Second Cataclysm, released in 1995.[118] In the game manual, Elon was credited below the heading Rocket Scientists.[38] “He [Elon] has that Bill Gates energy where his foot bounces and he’s wiggling just because he’s so smart,” one of his co-workers said.[51]

Someone who Elon hadn’t forgotten was Justine. While visiting friends back at his old university, he convinced Justine to go to a dinner date with him. They fit together - both grew up as social misfits, bullied, and lonely. “I was a really lonely kid and he [Elon] was a really lonely kid and that’s one of the things that attracted me to him,” Justine said. “I thought he had this understanding of loneliness – of how to create yourself in that. A lot of the things that come naturally to people he had to think about. It’s more deliberate with him. The lessons he had to learn were different from most of us. I don’t think people understand how tough he had it growing up.”[278]

“I see myself in you,” Elon told Justine.[182] When Justine didn’t watch the television series *Knight Rider*, *Fame*, or *A-Team*, she read a lot of books. At age five, she had learned how to read, and her first teacher thought she just stared at the pages to appear bright. “Reading was my first and earliest drug,” she said. “I’ve been reading since first grade, when I used my allowance to purchase a book in a bookstore for the very first time.” Like Elon, she didn’t want to go out on the playground during recess and lunch hour. She hid somewhere in the school building and read.[141]

After graduation, Justine moved to Japan for a year and then returned to Canada where she worked as a bartender while working on a novel as she was an aspiring writer. “If Elon ever calls me again, I think I’ll go for it. I might have missed something here,” Justine told her sister. Elon called her one week later.[182]

The Meaning of Life

"What's the meaning of life?" a young Elon Musk began to wonder. The reason why he asked the question was that he had a dark childhood where he experienced an existential crisis because he had read several books within the philosophy area. "Which you should not read at age fourteen," he said.

He read books by philosophers like Friedrich Nietzsche and Arthur Schopenhauer.[357] "The spirit now wills his own will, and he who had been lost to the world now conquers the world," Nietzsche wrote in the book *Thus Spoke Zarathustra*. But one of his favorite books was *The Hitchhiker's Guide to the Galaxy* by Douglas Adams. It covers several philosophical aspects and the storyline can be described as a combination of *Monty Python* and *Star Wars*. While reading it, Elon found his favorite spaceship of all times: *Heart of Gold*. What he really admired was the starship's engine. The engineer who designed the starship equipped *Heart of Gold* with an Infinite Improbability Drive – an engine faster than the speed of light.[342]

What Elon learned from *The Hitchhiker's Guide to the Galaxy* was that the tough thing is figuring out what questions to ask. But once you have it all figured out, the rest is easy. He realized we humans should aspire to increase the scope and scale of human consciousness to understand what questions to ask. The only thing that makes sense is to strive for greater collective enlightenment. That's the meaning of life.[51] This strive began in college. "When I was at Penn, I started thinking about what would most affect the future of humanity," Elon said.[57]

But why began Elon to think about these questions? Maybe it was because he read science fiction books. Isaac Asimov, one of Elon's favorite authors, thought science fiction will help you adjust to an ever changing world. "Very few people realize that change is inevitable and that it will occur more and more rapidly as time goes on," Asimov said. "So it's absolutely essential to consider the future in making our decisions… and to face that future with daring and guts. I believe no amount of reading in any field but science fiction is going to convince anyone of the inevitability of change."[455]

We will see that many of Elon's ideas can be traced back to Asimov, but Elon also used his engineering skills to dismiss several of Asimov's ideas. For example, Asimov was enthusiastic about the Space Shuttle, but Elon discovered that the Space Shuttle was considerable worse than the traditional rocket. Asimov thought that solar panels in space could solve our energy problems, but Elon discovered that it's way better to have solar panels on the ground back on Earth.

So the ideas began to form when the young Elon read books. "I read a lot of science fiction as a kid and tried to think about the future and the problems that needed to be solved to make it a bright future," he said.[66] Elon also talked about his ideas with friends and dates. "Do you ever think about electric cars?" he asked a date when they just met.[363] Several years later, one of the dates recalled that dating Elon was memorable.[322]

Elon came up with three things that in the future will most affect the future of humanity. "The three things that I thought would be the most effective were the Internet, the transition to a sustainable energy economy, and space exploration, particularly extension of life to multiple planets," Elon said.[57]

These three things were not the only ideas he thought about. He also thought artificial intelligence and biology would affect the future of humanity. "Rapid, low-cost, perfect DNA sequencing will have a huge effect on humanity," Elon said. "Human DNA has not yet been completely decoded. The most that anyone has gotten is about 91 or 92 percent, and that has been with a huge number of errors. Trying to read our DNA is like trying to understand software code - with only 90 percent of the code riddled with errors. It's very difficult in that case to understand and predict what the software code is going to do. That's a touchy subject."[370]

In an interview from the 1980s, Asimov talked about something that seemed silly. "In the old days, very few people could read and write," he said. "Literacy was a very novel sort of thing, and it was felt that most people just didn't have it in them. But with mass education, it turned out that most people could be taught to read and write. In the same way, once we have computer outlets in every home, each of them hooked up to enormous libraries, where you can ask any question and be given answers, you can look

up something you're interested in knowing, however silly it might seem to someone else." What he was talking about is known today as the Internet.[456]

A primitive form of the Internet existed as early as the 1970s. But the real revolution began the same year Elon landed in Canada, 1989. Tim Berners-Lee, who worked as a computer researcher in Europe, wrote a program that linked information on the Internet into what was called World Wide Web. Four years later, Marc Andreessen and Eric Bina developed the browser Mosaic. It's often described as the first graphical browser that made the Internet more user-friendly.

Computer enthusiasts and the academic institutions were the early adopters of the new technology. Like it is today, the Internet back then was used to exchange underground knowledge: how to pirate games, how to hijack long-distance telephone services, and how to make bombs.[122]

Elon's first exposure to the Internet took place when he studied physics and discovered the online physics-research community. In 1994, he thought the Internet could become the next big thing. "I don't remember one great Aha moment, when I suddenly had some grandiose commercial vision – that classic story entrepreneurs are supposed to have," Elon said. "What happened was, in working with the Web, I became absorbed by its astounding possibilities as a medium which could completely change the economics of the delivery of printed information."[265]

To find the same information before the Internet existed, we had to visit libraries or talk to wise men and women. "It's become a bit of a cliche recently to talk of it as a breakthrough as important as the Gutenberg printing press, but that doesn't make it any less astounding. Or less true," Elon said. "You can be in the jungles of Kongo and have a satellite link to the Internet and have access to essentially the entire knowledge of humanity."[265,354]

The best example of this collective knowledge of humanity has to be Wikipedia, which is an online dictionary written by anonymous Internet volunteers. Before Internet, we had to spend hundreds of dollars on encyclopedias that can't be updated if something new happens. Wikipedia is often updated within seconds after an event has happened. But we must be careful. Knowledge found on the Internet is not necessarily the truth. "Wikipedia is actually pretty damn good," Elon said. "It's really incredible what you can learn. It's like 90 percent accurate. It's just not clear what 90 percent."[443]

When Elon grew up in South Africa, he was exposed to several energy crises. One of them occurred after United Nations adopted a voluntary oil embargo against South Africa to force the country to abandon the apartheid system. “Between 1973 and 1984 the Republic of South Africa had to pay R22 billion [The rand, R, is the currency of South Africa] more than it would have normally spent,” the then South African President, P.W. Botha, said. “There were times when it was reported to me that we had enough oil for only a week. Just think what we could have done if we had that R22 billion today… what could have been done in other areas? But we had to spend it because we couldn’t bring our motor cars and our diesel locomotives to a standstill as our economic life would have collapsed.”[40]

Someone who also inspired Elon that the energy field is important was again Isaac Asimov. He was negative to the world’s future. In an interview from 1980, he thought the probability that our civilization will survive more than another 30 years is less than 50 percent as both our energy and food supplies will decrease. “Terrorism will also become a way of life in a world marked by severe shortages,” Asimov said. “Finally, some government will be bound to decide that the only way to get what its people need is to destroy another nation and take its goods… by pushing the nuclear button.”[455]

Elon realized that the largest single problem faced by humanity is sustainable production and consumption of energy. “If we don’t solve that in this century, we’re in deep trouble,” Elon said.[63] Each human living on this planet consumes on average nearly nine times as much energy as in 1850. More than 80 percent of this energy is provided by fossil fuels, and the problem with fossil fuels is that the world is running out of them.[42]

In 1859, we drilled the world’s first oil well in Titusville, US. It had a depth of 66 feet [20 m]. From these first wells, it became common to see large black pillars of oil shooting up from the ground when a drill struck oil. We had not yet invented the car, so we used this new type oil from below the ground to light our lamps. It was easy to find new wells, so the oil flooded the market, and the price of one barrel dropped to just $0.1 [1 barrel = 42 gallons = 159 liters]. But it’s no longer this easy to find new oil wells.[42]

Oil used to be algae on the bottom of lakes. Since the world’s geography always changes, these algae sank to a depth of between 7 500 to 15 000 feet [2 300 to 4 600 m] where they were turned into oil. This process happened 90 and 150 million years ago during two periods of warm climate, hence the fossil in the name fossil fuel. Because Mother Earth manufactured all oil

millions of years ago, the world has to realize the supply of oil is not endless. Sooner or later, the supply will reach a peak known as peak oil.[42]

The basic idea behind peak oil is a curve called Hubbert's peak. The geoscientist Marion King Hubbert, who used to work for the petroleum company Shell, developed the curve. Hubbert's peak says that for any given geographical area – from an individual oil-producing region to the planet as a whole – the oil production follows a bell-shaped curve. The top of the curve is the important peak. After the peak has passed, the supply of oil will decrease.[42]

Compared with opening a tap for water, extracting oil from a traditional oil field is more complicated. In the beginning, it's easy to extract the oil. But after the peak, when the oil workers have pumped up about 50 percent, they have to use several methods to get the last drop. One method is to inject water into the well. But the water will also begin to mix with the oil. In the end, the last liquid pumped up will consist of as much as 90 percent water and 10 percent oil. Ghawar in Saudi Arabia is the largest oil field in the world, and each day they inject as much as 7 million barrels of seawater into the field.[42]

Peak oil is a controversial topic. Those who believe in peak oil are often considered to be conspiracy theorists wearing tin foil hats. But peak oil isn't a conspiracy by environmentalists. It's a fact. The world consumes five barrels of oil for each new barrel of oil found, and this relationship can't last forever.[44]

The *Deepwater Horizon oil spill* in 2010 was the largest marine oil spill in the history of the petroleum industry. A total amount of 5 million barrels was lost in the Gulf of Mexico. You could argue that 5 million barrels are a lot of oil, but US alone consumes 20 million barrels of oil each day.[343] Why would you drill 5 000 feet [1 500 m] below the Gulf of Mexico if you could have found the same oil in a well on land? "That's why we have things like Deepwater Horizon, because Shallowwater Horizon is gone," Elon said.[1]

The question is when peak oil will happen. Elon expects this peak to happen around year 2020 and the world will finally run out of oil in 2050.[59] The current amount of oil available was estimated to 1 258 billion barrels. As the world consumed 87 million barrels per day in 2010, this oil will last for about 40 years.[343] But the world will never run out of oil. The last oil available will be so expensive that no one can afford to buy it. Depending on

who you ask, the consequences of higher oil prices will affect the world in different ways.

The most negative scenarios says that our society will become more like North Korea's. A plane ticket across the Atlantic Ocean will cost $50 000. We will use bikes, horses, and boats to transport what we used to transport with gasoline vehicles. It has been estimated that the production of food per area of grown food will decrease by 75 percent because fertilizers are made from petroleum products, so we have to leave the cities and begin to grow our own food on the countryside.[42]

The most positive scenarios says that as the price of oil increases, the society will automatically transform into a society not dependent on oil. "The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil," a Saudi oil minister said. Consumers will become more positive to electric cars because it's too expensive to drive the cars with a gasoline engine. To fly across the Atlantic Ocean, engineers will invent airplanes powered by electricity. This is the scenario Elon believes in. "For energy, you do have a gradual increase in the price of oil and changes in the supply curve, which will force innovation," he said.[52]

We can find several examples of this forced innovation if we look a few years back in time. In 1973, the first global oil crisis hit the world with full force. Several oil exporters from the Middle East limited the supply of oil because US supported Israel during the Yom Kippur war. The price of oil skyrocketed. Gas stations had to shut down because no oil was available, so people began to steal gasoline. There's a famous picture from the era with a boy together with what's most likely his father. The father carries a revolver and the boy is holding a sign saying, "Gas stealers beware! We're loaded for Bear!"[41]

But after the crisis ended, you could see how the society had adapted itself to the new conditions. While US as a whole became 32 percent more oil-efficient, vehicles became 50 percent more oil-efficient. To set an example, the former US President Jimmy Carter installed solar panels on the top of the White House. "A generation from now, this solar heater can either be a curiosity, a museum piece, an example of a road not taken," Carter said. America chose the latter when the solar panels disappeared during President Ronald Reagan. The panels were not installed again until Barack Obama became the President.[43]

Another energy crisis took place in Cuba. After the fall of the Soviet Union and after an increased blockade by US, Cuba couldn't import oil and entered a period known as the Special Period. Blackouts could last for sixteen hours a day, and they had to rope buckets with water to the top of the tallest buildings. As an act of desperation, they imported 1.2 million bicycles from China and the Cubans themselves manufactured 500 000 more.[44]

But in a similar way as after the 1973 energy crisis, the Cuban society adapted to these new conditions. It became common to hitchhike and government cars were required to pick up anyone who wanted a ride. The Cubans developed the Camel truck with a capacity to carry 300 people. In small towns, the Cubans used horses and mules to transport goods. They ate less, and they walked and biked across the country, so the average Cuban lost 12 pounds [6 kg]. This healthier lifestyle decreased the number of heart attacks, diabetes, and strokes. Solar panels were too expensive for most households, but 2 000 schools were equipped with them.[44,45]

Peak oil and global warming are often confused with each other. There's an owner of an electric car who has a bumper stick on his car saying, "Environmentalists took money from the poor to pay me to buy this car."[206] But it doesn't matter whether global warming is a hoax or not - what matters is that we are running out of oil. Elon has always been someone who's a big fan of facts, and peak oil is a fact. "It's not like there's some infinite oil supply," Elon said. "If there was hypothetically no environment or national-security issue, and all the oil in the world was in the US, we would still need to find a sustainable mode of transport because the oil will run out, and there will be economic collapse. We will run out of even the fracking resources."[363,366,433]

Before we run out of oil, we have to save at least some of it. "I think we should be saving our oil resources for the future when we really need it and make sure that it's applied for the highest use in the economy, which would be things like pharmaceuticals and plastics production," Elon said. "We shouldn't really be burning the stuff in our cars. It's pretty valuable as an industrial ingredient."[433]

So the first reason why we need a sustainable energy economy is peak oil. The second reason is environmental reasons. A world without oil will be cleaner than a world with oil, but a world without any fossil fuels is the best alternative. Elon is not a fan of global warming since it's a dumb experiment. "They often say 'How do we know for certain that CO2 emissions cause

global warming?'" Elon asked. "If you ask a scientist 'Do you know anything for certain?' they generally say 'No we don't know for certain, we don't know anything for certain' But the overwhelming opinion of the scientific community is that the CO2 is causing global warming. Given that we will run out of oil anyway, it doesn't make any sense to put trillions of tonnes of CO2 in the atmosphere and see what happens, which could be catastrophic. It's just a dumb experiment."[341]

The CO2 experiment is comparable to the cigarette experiment. It was popular on Earth several years ago, and some are still participating in it. "In the early days of smoking they used to think that smoking was fine," Elon said. "This link between lung cancer and smoking was completely ridiculous. They had like pregnant women in ads smoking. It was difficult to prove an exact link. Everyone that smoked didn't get lung cancer. 99 percent of the scientists thought that smoking is bad for your health. The smoking lobby would say 'Scientists disagree.'"

To accelerate the transition from a society dependent on fossil fuels, Europe has a tax on petrol that favors fuel-efficient vehicles. Elon wished the US had a similar tax.[66] "Even though I've got companies trying to address the problem, I drive cars, I use more electricity than I should," Elon said. "It's tough to tell people you're causing long-term harm to the world, and even if you don't pay the penalty, your children or grandchildren will. So essentially we need to tax it, the way we tax cigarettes and alcohol, for the public good."[316]

Another way to accelerate the transition from a society dependent on fossil fuels is to have stronger incentives for solar, wind, geothermal, and hydro energy. Nuclear power, which is a cleaner alternative than coal or gas, can be an alternative. "It's [nuclear] the lesser of the evils – not ultimately the best. But not wise for California," Elon said. Because California is in an earthquake zone, it's a less good area for the construction of nuclear power plants.[66]

What we need is a complete system of both sustainable power generation and consumption. But we tend to prioritize smaller solutions, such as recycling of garbage. "Recycling of garbage and stuff like that is important but pales in significance to having sustainable clean power generation and consumption," Elon said. "The world is not going to die because of Coke bottles."[452]

Largely because of the financial crisis that began in 2008, several concerned citizens have begun to prepare for a collapse of our society. This is not something new as it has happened several times before. The investor Warren Buffett's father, Howard Buffett, lost faith in the US dollar and bought gold and a farm to prepare for a collapse of the financial markets.[65]

Buffett is a person Elon admires.[326] The Giving Pledge is a philanthropic campaign by Buffett and Bill Gates, and Elon is one of twelve billionaires who has signed it and will give at least half of his wealth to charity. "Just signed giving pledge with eleven others. I hope this announcement convinces others to do the same," Elon said.[56]

Preparing for unexpected events is generally a good idea. After the *Hurricane Katrina* in 2005, everyone saw how difficult it was for a government to help a large amount of people in need. But some take this preparation to the extreme, and the reality series *Doomsday Preppers* popularized it. The series shows US citizens who are preparing for everything between heaven and earth, including a collapse of the financial market, a nuclear war, and a worldwide pandemic.[64]

The preppers, as they call themselves, buy large amounts of weapons and food. While some preppers construct large underground bunkers and defenses, others rebuild old military trucks to be able to escape into the wilderness. Some believe hiding out in the middle of the ocean is the only way to survive, so they prepare large boats. One planned to escape from the US to safety in the jungles of Costa Rica.

Entire industries have grown up to help people prepare. One company specialized in building bunkers with flushing toilets, hot water, and surveillance cameras. To build these bunkers, that could be hidden four floors below the ground, they hire workers from another area to make sure no one except the owner of the bunker will get to it if something happens. Another company specialized in training people how to escape by foot from New York to a safer place.

But no one in the television show is as extreme as Elon, who want to escape to other planets. "I really believe it is a matter of when and not if, and that when is probably a lot sooner than most of us are comfortable thinking about," Elon said. "Things have happened quickly. It took us millions of years to evolve into what we are, but in the last 60 years, with atomic weaponry, we've created the potential to extinguish ourselves. And if it's not us, it will inevitably be something else. If not a meteorite in the relative short

term, then the expansion of the Sun's corona. It will happen."[49] He added a number of other threats with the ability to extinct life on Earth. They include an engineered virus unleashed by terrorists, an inadvertent creation of a micro black hole, or a yet unknown technology.[61] To save mankind from these catastrophes, we need to begin living on other planets.

When we have begun living on other planets, it will be a so-called "epochal moment." These are not moments in the history of mankind, these are the life's turning points. Curing cancer will be a moment in the history of mankind, but from a broader perspective, no one will remember when we found the cure for cancer. "People think of curing AIDS or cancer as being very important, and they are – within the context of humanity," Elon said. "But curing all forms of cancer would improve the average life span by only two to three years. That's it."

The first epochal moment was the advent of the single-celled organism, the second was the emergence of multi-celled life, the third was plants and animals, the fourth was the move onto land, the fifth was the mammals, and the sixth was the consciousness. The seventh epochal moment will happen when we begin living on other planets. "A million years from now, when most of what we see is forgotten, the point at which humans were no longer limited to one planet will be remembered," Elon said. "It's important enough to be on the scale of life itself, and therefore goes beyond the parochial concerns of humanity. We're all focused on our little things that are of concern to humanity itself."[49,287]

Isaac Asimov, who said, "I definitely believe that humanity's destiny will be found in expansion beyond our planet's surface," shares these ideas. Asimov also talked about what he called real changes, like nuclear power and the jet plane, and compared it with changes that are more trivial. "What difference did it make to the people of the ancient world that Alexander the Great conquered the Persian Empire?" he asked. "Obviously, that event made some difference to a lot of individuals. But if you look at humanity in general, you'll see that life went on pretty much as it had before the conquest."[455]

The big question is why we should begin living on other planets when we still have problems here on Earth. We tend to be negative to the world. It's easy since the Earth is in a mess with never ending civil wars, dictators with nuclear weapons, and people who can't find clean water. But remember that Elon is a big fan of facts and they say that the world is becoming a better

and better place to live in. We are just not seeing it. “If anyone thinks they’d rather be in a different part of history, they’re probably not a very good student of history,” Elon said. “Life sucked in the old days. People knew very little, and you were likely to die at a young age of some horrible disease. You’d probably have no teeth by now.”[117]

In an interview, Elon referred to the article *A History of Violence* by Steven Pinker. The article reveals that the world has become a better place to live in. According to Pinker’s research, the murder rate has declined from 24 homicides per 100 000 Englishmen in the 14th century to 0.6 by the early 1960s. The number of battle deaths in interstate wars has declined from more than 65 000 per year in the 1950s to less than 2 000 per year.[303]

Hans Rosling, who is a Swedish medical doctor and public speaker, has shown that we have preconceived conceptions about the global health. In a survey, he asked several questions about our world’s health. One of the questions was, “What do you think is the life expectancy in the world as a whole today?” 24 percent answered 50 years, 54 percent answered 60 years, and 22 percent answered 70 years. What do you think? The correct answer is 70 years. Another question was, “What percentage of adults in the world today can read and write?” The correct answer is 80 percent, but only 22 percent of the polled chose that answer.[444]

The reason why we are more negative to the world than we should be is simple: We read newspapers both offline and online and watch the news on television. “The daily news media tends to focus on the worst thing occurring in the world at any given point,” Elon said. “It should be called ‘What is the worst thing on Earth today?’ There is something in the human psyche that tends to place a weight on negative stuff, more than positive.”[357]

Rolf Dobelli released the report *Avoid News – Towards a Healthy News Diet*. The idea behind the report is that human beings are still cavemen. Our brains are optimized for our original hunter-gatherer environment where we lived in small groups with limited sources of information. We now live in a world where news is available in abundance, and we can’t handle it. Dobelli argued that news media focus on the visible. While they display whatever information that include dramatic stories and pictures, they ignore the less dramatic stories, even if that material is more important. They show when an airplane has crashed, but we don’t hear anything about our bodies increased resistance to antibiotics, which is much more dangerous but doesn’t feature

any dramatic pictures.[304] It's not strange that journalists have a saying: "If it bleeds, it leads."

What's often forgotten is what we may discover when we begin living on other planets. The cure for cancer? The solution to the food crises around the world? "We set sail on this new sea because there is new knowledge to be gained, and new rights to be won, and they must be won and used for the progress of all people. For space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man. I realize that this is in some measure an act of faith and vision, for we do not now know what benefits await us," the former US President, John F Kennedy, explained in a famous speech from 1962.[19]

Elon has similar ideas as Kennedy. "If we are able to establish life on another planet, it requires us to learn a lot about climate and maintaining a climate equilibrium," he said. "So there's a huge amount we would have to learn in trying to establish life in a hostile environment and that we then could translate back to Earth."[358]

Several new ideas are the result from unexpectedness. While Alexander Graham Bell tried to invent a hearing aid when he invented the telephone, Christopher Columbus discovered America when he tried to find the shortest passage to India. Alexander Fleming discovered the medical virtues of penicillin when the mold infiltrated a sample he had left by an open window.

Steve Wozniak, who co-founded Apple, argued that technology always moves us forward. "I realize that when engineers create something there is often an argument that the creation could be used for bad or good. Like the atomic bomb," he said. "Inside my head – and this is what has really stayed with me – I came to the view that basically, yes, technology is good and not bad. People argue about this all the time, but I have no doubts about it at all. I believe technology moves us forward. Always."[17]

There are several examples where new technologies have improved the world. During the Cold War, Vice President George Bush encouraged Apple to get computers into Russia to "foment revolution from below."[3] Several of the world's 70 space endeavors aim to improve communications, mapping, and weather observations with the help of satellites. India is a poor country, but India has a space program. In 1999, a cyclone hit India's east coast and killed more than 10 000 people. But because of satellites, a recent cyclone killed only a few people. Indian weather satellites had helped to predict where and when the storm would hit.[414]

Yet another reason why we need a space program is less visible. Before NASA launched a Saturn V rocket, Ralph Abernathy arrived to the launch site. After the assassination of Martin Luther King, Abernathy became the new leader of the Poor People's Campaign, which was an effort to gain economic justice for poor people in the US. Together with hundreds of people, he protested against what they thought was a waste of money. "We are protesting America's inability to choose the proper priorities," Abernathy said. "It's really not about the capability to do this, it's this money that's going to the Moon, this money's going to be on the Moon, and it should be being spent on these people down here on Earth."[15]

Before the countdown to launch hit zero, NASA invited Abernathy to watch the launch from the VIP area. "If it were possible for us not to push the button tomorrow and solve the problems with which you are concerned, we would not push the button," a NASA employee told the group when they entered the area.[15]

Miles away from the launch platform, everyone in the VIP area could feel the vibrations as the Saturn V launched and roared away from Earth. "I succumbed to the awe-inspiring launch. I was one of the proudest Americans as I stood on this soil," Abernathy said after the launch. "This is really holy ground. And it will be more holy once we feed the hungry, care for the sick, and provide for those who do not have houses."[28] What had happened was that the vision of the space program had inspired Abernathy. For just two minutes, he had forgotten there were citizens too poor to afford food.

Inspiration is often a forgotten result of an endeavor. Elon thought a new space program could inspire people. "I think we're at the dawn of a new era and I think it's going to be very exciting," he said. "What we're hoping to do is to push the envelope and provide a reason for people to be excited and inspired to be human. Literally over a billion people saw that mission [the Moon landing]. People walked hundreds of miles to the only television set available in one village."[308,365]

The Outsider

Elon Musk wasn't sure if he could work within the three areas that in the future will most affect the future of humanity. No matter what Elon is working with, he believes he can affect the world in a positive way by working with it, and he believes that's the most important factor when founding a new company. But he added that it wouldn't hurt if he also could make money from his endeavors.

While studying, Elon became interested in electric vehicles because they can save the world from its dependency on oil. Now when he had graduated he wanted to create a new battery for these vehicles. To create this new battery, he needed to use the laboratories at the Stanford University, California. So in 1995, Elon began a PhD graduate program in materials science & applied physics. His thesis idea was to use advanced chip making equipment to create a solid state capacitor with enough energy density for use in electric cars. "High-energy physics is where some major technical revolutions are going to come from," Elon said. "By getting down to the quantum plane, it's going to make much more power available more cheaply and with less pollution."[265]

The PhD degree itself wasn't important to Elon. What he wanted was the results of the research. His goal was to replace a traditional battery with a new super-battery that can charge in a matter of seconds. Such a battery would fit perfectly inside of electric vehicles. The large drawback with them is that it takes a long time to charge the battery compared with the time it takes to fill up the tank in a gasoline car.

At the same time as when Elon decided to save the world from its dependency on oil, Internet had begun to grow. His choices now were to either remain at Stanford and just watch as the Internet changed the world or leave Stanford and come back later. He thought the probability to succeed was much higher if he pursued the Internet compared with the research he made, so after 48 hours, Elon said goodbye to Stanford. "I thought that if I spend five to six years working on a PhD at Stanford and then came up with the idea that this wasn't possible. That would really be terrible," Elon said.[233]

In hindsight, he thought that failure would have been the most likely outcome of the PhD studies – the technology wouldn't have worked as expected.[350]

Elon decided not to quit the graduate program, but to get a deferment to give the Internet a chance for six months. If this Internet turned out to be a flaw, or if his ideas failed, he could always return and pursue the graduate program. "It was a tough decision," Elon said. "I'm not a born risk taker. I also had a scholarship and financial aid, which I'd lose. Being young helped. So did the fact that the field was literally brand-new, with no experts. But I'm a realist, so I hedged it and took a deferred admission from September to January."[265]

When Elon told the chairman of the department at Stanford he wanted to start a career within Internet, the chairman thought Elon would fail. "Well, give it a shot, but I'll bet we'll see you in three months," the chairman said. On the other hand, his professor at Stanford thought he would never return.[265]

Now Elon set out to find a job related to the Internet. "It was hard not to try and see if I could push it [Internet] forward," he said.[265] In the early years of the Internet Age, it was almost impossible to find a company in the industry that at the same time wanted to recruit inexperienced employees like Elon.

A popular web browser in the 1990s was Netscape Navigator with a market share of 90 percent. Years later, Netscape Navigator would lose its market share to Microsoft's Internet Explorer. "Microsoft should not be allowed to own the browser market," Elon said. "If they do, they will own the gateway to the Internet for every consumer and it's almost certainly likely to result in a less valuable experience for the consumer."[264]

Netscape needed to recruit new employees, so Elon tried to get a job there. But he failed for unknown reasons because he received no reply on his application. He became desperate and decided to visit the Netscape office with his resume. As he was shy, he dared not speak to anyone, so he just hung around in the lobby before he went home again.

Elon knew he always wanted to work within an area where he could invent a sufficiently advanced technology that's indistinguishable from magic – like in his favorite quote by Arthur C. Clark. But he was never sure if he wanted to do that in an existing company, or if he had to create his own company.[324] Because he didn't get a job at any of the few Internet companies, he realized he had to create his own job.

In the same year as eBay was founded, 1995, Elon founded Zip2 during the summer months. “I was very naive and much stupider than I am now,” Elon said. “I wish I could go back and give myself a slap on my face. I was working crazy hours. I would literally sleep under my desk to avoid going home because that’d just take time. I was trying to make up for my mistakes by working really, really hard.”[431]

The first mistake was the name Zip2. “Terrible name,” Elon said. “We were incredible stupid at the time, that’s the main reason for that name.”[363] The problem with the name was that it would be difficult to know how to spell it after someone told you to visit zip2.com. Will you spell it zip2.com, zipto.com, ziptwo.com, or ziptoo.com? It would have failed the “drunk-test.” That test says that you should be able to say the name of your website to someone who’s drunk and the person should know how to spell out the name.

Mainly because he didn’t know anyone in the San Francisco area where Zip2 was founded, Elon was the only employee. But he felt he needed co-workers. The two brothers Elon and Kimbal had one year earlier been on a road trip from Silicon Valley to Philadelphia. During the journey they talked about founding an online medical database.[320] Kimbal, who had studied at the Queen’s University in Canada, and now joined an Internet hardware firm as a market analyst and sales manager, decided to join his brother.[262] They had both finished school the same year. Elon is one year older but had decided to remain one more year to get a second degree. Also a friend of Elon’s mother, Greg Kouri, was convinced to join Zip2. Kouri worked as a real estate developer in US and Canada.[18] Both Kimbal and Kouri joined Elon in the fall of 1995.

Elon didn’t have any experience from the Internet industry or how to build a company. But since the genius boy is a fast learner, he could learn everything he needed to know along the way. No mentors were available, so he gained most knowledge on how to build a company by reading books and through learn by doing.[324] “I think you could learn whatever you need to do to start a successful business,” Elon said. “There are examples of successful entrepreneurs who never graduated from high schools, and there are those with PhDs. So I think the important principle is to be dedicated to learning what you need to know.”[364] But he added that a degree would speed up the learning process.

Not knowing anything was in retrospect an advantage. “I’ve found that being an outsider helps you to think creatively about improving the way things are done,” Elon said. “When people have been doing things the same way for years, they stop questioning their methods even if they defy common sense.”[263]

They never expected to make a large sum of money from this Internet venture. Elon wanted to make enough money to support himself since he had only $2 000 in the bank account. He also owned a car and a computer.[71] From his studies at the university, Elon accumulated a large sum of student loan he now needed to pay back together with interest on the loan.

Because they had so little money, their goal was to make money as early as possible. They decided to target the media industry because they believed the media industry had the money they needed to survive. Zip2 would help the media industry to convert their content in print to online content.

The first thing Zip2 did was to contact the company Navteq, which was founded by another South African immigrant. Navteq produced digital maps used in various navigation applications, such as GPS navigators. Elon persuaded them to let Zip2 put their maps on the Internet. Then he purchased a business directory for a few hundred dollars. Elon linked the business directory to the map with a software he developed himself.[71] “I still had my core programming skills, so I was able to write the software,” he said.[327]

As they continued to develop their product, they branched out to more areas than was covered by the original business idea. Visitors to Zip2 could look up a movie, and then find a restaurant or nightclub in the same neighborhood. The Zip2 software could also give visitors door-to-door driving directions. “It [Zip2] did a bunch of things,” Elon said. “It was Internet publishing, mapping, yellow pages, white pages, calendar. Basically, what my first company really did was to help bring the media companies online.”[321]

This was the first description on their website:

> Every year, businesses in your community spend thousands or even millions of dollars on advertising in order to provide you with information about their products, promotions, and services. This information comes through the mail, the print Yellow Pages, and many other forms you see and hear every day. However, despite all these

> efforts, you simply don't always find the information you want when you want it… and here's where the Internet can help.
>
> The Internet not only allows you to get the depth of information you need about a business faster and more cost-effectively than any other source, it also allows you to go a few steps further. Through the Internet, you have the ability to communicate with that business once you've found it; the ability to get a map showing you where that business is relative to other businesses; the ability to look for businesses by proximity to your home; the ability to get door-to-door directions to that business, and many more. Zip2 not only brings you all of these benefits, but it is focused on continuing to provide new and innovative features in the years to come.[262]

The 1996 version of the Zip2 website featured a blue logo, which consisted of a running person where the legs form a lightning. You could search on the site, and the main heading said, "Search accurately for over 16 million businesses in the USA…" Zip2's Management Team page revealed that, "Elon published his first computer program at age 12 and four years later achieved the highest possible grade in the IBM aptitude test for engineers."[262]

Zip2 rented an office in Mountain View, California. The monthly rent was about $450, and it had a leaky roof. "It was just the nastiest place you can imagine," Elon said. "It was way cheaper than a garage. Garages are expensive." They didn't have a home to live in because the apartment was more expensive compared with the office, so they got rid of the apartment. "When you are first starting out you really need to make your burn-rate ridiculously tiny," Elon said. "Don't spend more than you are sure you have."[436]

They tried to repair the roof, and during the night they slept in the office on futon sofas, which is a Japanese type of furniture that easily transforms from bed to sofa. The futons were placed in the meeting room. To shower, they went to the El Camino YMCA. The facilities included a gym where they exercised, so they were all in good shape. Regular exercises were a good idea since they frequently ate at the low-cost fast-food restaurants Jack in the Box and White Castle.[4,71,258,264]

One floor below Zip2's windowless office, a smaller Internet service provider had their own office. To get a fast Internet connection to Zip2's office, they drilled a hole through the floor and connected the cables. For this connection, they needed to pay $100 per month, and it was a large improvement for the company. They had previously used Elon's own computer and a dial-up modem to run their website. "I'd program it in the night and turn the server on during the day," Elon said.[71]

All these smaller savings meant the company had low expenses, and they had some revenues. It didn't take long before Zip2 had a positive cash flow – a fact they could brag about when they searched for outside investors. But the life of a Zip2 employee was still far from luxurious. They had so little money that Elon and Kimbal's mother Maye had to pay for colored copies of their business presentation they needed when they presented their company in front of outside investors.[417]

In 1996, the fish took the bait when the venture capitalist firm, Mohr Davidow Ventures, invested $3.5 million for less than 50 percent of the company. Elon thought they were crazy who had given him all this money. "Do they have any idea what they're doing giving me all this money?" he asked. "I was terrified of blowing that money." In total, Zip2 would get $38 million more in funding.[71,265]

Zip2 had earlier asked other venture capitalists if they wanted to invest in the company, but they declined because most of them had never heard of this Internet. "Back in 95, there weren't many people on the Internet and nobody was making any money at all. Most people thought the Internet was gonna be a fad," Elon said.[27] One venture capitalist threw a phone book at them and asked, "Do you really think Internet will replace this?"[320]

The reason why everyone now wanted to invest in Internet companies was that Netscape became a public company in 1995. This was, however, not the largest IPO this year. Pixar's – another technology company famous for movies like *Toy Story* – was larger. But while Pixar's stock increased with only 77 percent the first day, Netscape's stock increased with 107 percent. It was clear that technology, especially Internet, was the hottest investment. "Netscape went public in late 95, and that was the first inkling that – even if nobody was making any revenue on the Internet – at least there was some greater fool who would buy the stock," Elon said.[57]

Elon's first car was a used 1978 BMW 320i with a price tag of $1 400. The car was in a miserable shape, but Elon fixed it up himself. He owned it

for two years, and once, he loaned it to an intern who worked at Zip2. While the intern drove the car, one of the wheels fell off. The intern called Elon who rushed to the scene. He recalled how he could see the scratches in the road made by the axle where the wheel had been attached.[124]

When Elon was seventeen years old, someone gave him a book on classic convertibles. The car he liked the best was the Jaguar. He would later buy one for himself, but had to wait until the venture capitalists invested in Zip2. They gave Elon $40 000 as a bonus, and $35 000 immediately went to a 1967 Series 1 E-type Jaguar. While the E-type is considered to have the best car design ever made, it's also unreliable. Elon recalled that the "Jag" was like a bad girlfriend since it kept breaking down. It even broke down on the way home from the car dealer.[124]

To get this first investment, Elon agreed to replace himself as CEO of Zip2. Replacing an inexperienced CEO with an experienced one is a common thing to do in new companies as they grow, and Elon assisted in the recruiting process. They decided that Rich Sorkin was best suited to become the new CEO. Sorkin had a degree in economics from the Yale University and an MBA from the Stanford University Graduate School of Business. Before joining Zip2, he worked at companies such as Goldman Sachs and Creative Labs. When he took over the rudder, Elon thought it was a good idea because the value of his shares in Zip2 would increase if they hired a competent CEO. But he would later regret the decision to step down as CEO.[71,324]

As Elon is a person with strong views, he didn't always share the new CEO's vision. Zip2 wasn't a consumer company with a recognized brand name. The only clue a website was a part of Zip2 was that it included a smaller logo with the text "Powered by Zip2." Elon wanted more visibility, and visibility to him meant he wanted his picture on the front page of a magazine.[263] "I'd like to be on the cover of Rolling Stone, that would be cool," Elon said.[27]

Elon lost more and more power. Due to all the new investments, his share of the company decreased. Four out of seven board members consisted of the new investors: Knight Ridder, Hearst, and The New York Times. These board members also represented the clients, so Elon didn't have much influence regarding the company's future direction. "What they should have done is put me in charge," Elon said. "That's OK, but great things will never happen with VCs [venture capitalists] or professional managers. They have

high drive, but they don't have the creativity or the insight. Some do, but most don't."[71]

In 1998, Zip2 began to discuss with the company Citysearch if they could merge into a larger, more competitive company. Citysearch was involved in the same business area as Zip2. If the companies merged, they thought the larger company could compete with Microsoft's Sidewalk – another similar service. Zip2's board approved the merge and published the deal in a press release. But the merge never happened. Elon had talked with Charles Conn, who was the CEO of Citysearch. While the original plan was that Elon remained in the new company, Elon thought Conn would force him to leave the company after the merge. So Elon and his brother decided to say no to the merger of the two companies.[263]

The failed merger resulted in that Zip2 forced Elon to give up his position as the chairman of the company and Sorkin lost his job as CEO. Derek Proudian, who was the first venture capitalist to invest in Zip2, took over as CEO.[71]

In April 1999, Compaq bought Zip2 for $307 million in cash. It was the largest sum up to that point ever paid for an Internet company.[57] Elon made $22 million since he and Kimbal owned about twelve percent of the company.[59] The reason why Compaq bought Zip2 was that they wanted to merge Zip2 with Altavista to compete with Yahoo.[319]

But Elon was angry at the investors. He thought they sold the company way too early. Zip2 could have been worth ten times the amount they sold the company for. The software Zip2 had was as good as the software the much larger companies Yahoo and Excite had.[363] Elon wanted to help build the Internet, but he had just built software for newspapers like *The New York Times*. And in 2013, the company is almost forgotten. "After Compaq bought my company, it was merged with Altavista and the combined entity was rather poorly managed by execs whose main background was making PCs in Texas," Elon said.[259]

After just a few years in the Internet industry, Elon had the option to retire. "I guess it'd be really easy for me to spend the next 40 years doing absolutely nothing, hanging out, buying an island," he said. "The idea of lying on a beach as my main thing sound horrible to me. I would go bonkers. But I like to go to the beach for a short period of time, but not much longer

than a few days."[265,363] Elon didn't buy an island, but he bought a large house and a McLaren F1.

Joining the Mafia

Elon was bored. But as we've seen before, boredom can lead to great things. "It's not that I'm a workaholic, I don't think," Elon said. "Actually, I just can't resist seeing and being a part of what's going to unfold with the web over the next decade or so. I'm still endlessly curious about how it will evolve. I know it's nowhere near fulfilling its potential. I'm much more interested in trying to create a new company. It's sort of like a series of poker games."[265,266]

Elon asked himself what opportunities remained within the Internet area. He realized that not much innovation had happened within the financial services sector. "The banks are terrible at innovation, and financial services is a huge sector, so I thought, there should be something here," Elon said.[71] This was the poker hand he wanted to play. "I've gone on to a more high-stakes poker game and taken my chips with me," he said. "And I haven't gone and taken my winnings and spent a big chunk, but I've just really put almost all of it back into the new game."[266]

He had earlier shunned the idea to work as an employee in the finance industry. "I wanted to have a sense I was working on something having a fundamental impact on people's lives, and going to Wall Street or into a large corporation, I became sure, was not going to be a way of doing that," he said.[265]

What he didn't have any problems with was to reinvent Wall Street with an entrepreneurial company. "Something about the culture of startups, at least at this point in my life, seems inevitable," Elon said. "It's more fun, the atmosphere is more creative, and I think more gets accomplished."[265]

Elon founded X.com in March 1999. He was not yet thirty years old. Their website answered the question why they had chosen the name, "Why not? X is simple, straightforward, and lacking in pretense and fluff – exactly like our approach to financial services."[394]

Elon was the CEO, but took the position as chairman of the board after the former Intuit CEO, Bill Harris, became the CEO in late 1999. In an article in the newspaper *The Wall Street Journal*, Harris explained how he had

received offers from more than 100 startups, but he chose X.com because he saw it as a blank canvas upon which he could write new rules on the delivery of financial services.[189]

This was at the height of the dot.com bubble, but Elon knew it was a bubble, so he wasn't nervous. "Any change this profound is bound to set off speculative frenzy, and people need to do their homework, and not blindly buy into companies that aren't well put together," Elon said. "There are a lot of Potemkin villages out there built on flimsy foundations and many, many will fail. There's going to be a lot of weeding out in the future. This is the longest peacetime expansion in history, and for young people who've never really seen a serious recession – and anyone who's studied history knows they happen – a downturn will be a rough experience. [But] the radical cost advantages the net brings are real and viable long-term."[265]

After the burst of the dot.com bubble, those who knew Elon had founded an Internet company asked his wife, "So are you guys all right?" They had obviously not noticed that Elon's McLaren F1 was still parked in their garage, so she assured them they were doing okay.[142]

Elon's ambitious vision was that X.com would become a financial supermarket. This supermarket included an online bank, a mortgage broker, an insurance vendor, and a mutual fund company. "The huge brick-and-mortar financial institutions, the Bank of Americas, the Chase Manhattans, the Citibanks, all have gigantic investments in existing assets, which include thousands of branches, millions of tonnes of concrete, steel and glass, legacy information systems, and organizational boundaries between service divisions," Elon said. "From a consumer standpoint these make the coordination of different services into a unified package expensive, complicated and confusing. A really well-done, pure Internet-based service, without all that overhead baggage, could pass along enormous savings to consumers in the form of discounts."[265]

The only real experience Elon had from the finance industry was a short internship at the Bank of Nova Scotia and a tiny detour as an amateur stock trader in South Africa.[56] So Elon used the same strategy as when he founded Zip2: read books and learn by doing. Now he could also use his experience from Zip2. "I guess my expertise is that I know how to build a killer Internet company with a solid foundation," Elon said. "I didn't know anything about the media business when starting Zip2, but figured it out along the way."[263]

Compared with the birth of Zip2, the largest difference now was that a venture capitalist had from the beginning invested in X.com. At the time, it was a mystery who had invested in the company, but it was later revealed that Sequoia Capital had invested $25 million. The venture capital firm was founded in 1972, and are famous for their investments in companies like Apple, Google, and YouTube.

With money comes the luxury of having a decent office. No water leaks. No futon sofas. No drilled holes in the floor just to get an Internet connection. And, above all, no low-cost fast-food restaurants as X.com's office was above a bakery close to the Stanford University in California.

X.com developed the main product where their customers could see all their bank accounts, insurances, and everything else they could need. This was an easy task, but it still took a long time to develop the product. "Money is just an entry in a database," Elon said.[354] They also got some attention in the industry with a no-fee S&P 500 index fund – the first of its kind. The purpose of the fund was to attract new users who could pay for their other products.[189]

With the main product ready, they developed a smaller feature as a complement to the main product. It took a day to develop the smaller feature, and it was a way to e-mail money from one e-mail address to another. It didn't have to be an e-mail address, you could use any unique identifier. It was also possible to transfer stocks, mutual funds, and similar assets. If the recipient didn't have an X.com account, the system automatically sent an e-mail where the recipient was asked to register for an account.

When X.com demonstrated these two features, they realized the smaller feature was more popular. "Whenever we'd show the system off, we'd show the hard part, the conglomeration of financial services, which is difficult to put together, nobody was interested," Elon said. "Then we showed people e-mail payments, which was easy to put together, and everyone was interested. So, it's important to take feedback from your environment. You want to be as closed-loop as possible."[63]

Because of this new insight, X.com decided to focus on e-mail payments. To succeed with e-mail payments, and because of Metcalfe's Law, growth of users would become the most important task. Robert Metcalfe came up with the law and it says that the value of a network equals the square of its users. A network with twice as many users as a competitor is four times as valuable. So to crush the competitors, X.com needed to achieve a so-called

network effect which says that a large established network is valuable to enter and costly to leave. If many people used X.com, it would be difficult for competitors to attract new customers because everyone is already using X.com. They wanted to lock in their members to prevent competitors from growing. This is why it's difficult for Google+ to attract users from Facebook.[189]

To achieve this network effect, Elon came up with a clever way to attract new customers. X.com offered $20 to anyone who opened an account, and members who referred new customers were awarded $10 for each referral. "X.com is really a perfect case example of viral marketing where one customer act as a salesperson for you for bringing in other customers," Elon said. "So you had this exponential growth. It was like bacteria in a petri dish. We didn't have a sales force. We didn't spend any money on advertising."[364]

Within two months, X.com had 100 000 customers. This number can be compared with the then largest web-based bank, Etrade Telebank, that had 130 000 customers. But X.com wasn't the only company in the payments industry. X.com's office had shared common space with a company called Confinity before they needed a larger office.

The Ukrainian born Max Levchin had early learned how to program on whatever he could find. When his family moved to US in 1991, he went through dumpsters to find things to rebuild while he taught himself English by watching television. A degree in Computer Science from the University of Illinois taught him how to create and break codes.[261] "These crooks are intelligent, but they leave clues. I'm the Sherlock Holmes of the Internet underground," Levchin said.[185]

In the summer of 1998, at the same time as when Elon fought for the future of Zip2, Levchin didn't really know what to do with his life. What he knew was that he wanted to start a company within his passion: cryptography. To come up with new ideas, he took a random lecture at the Stanford University. The subject was "The link between market globalization and political freedom," and the guest lecturer Peter Thiel gave the lesson.[393]

While Thiel was born in 1967 in Germany, his family moved to California when he was young. Stanford was the school of his choice before he began trading derivatives at the Credit Suisse Group. In 1996, he founded the hedge-fund Thiel Capital Management, and he's also famous for being

the first outside investor in Facebook. Thiel has also donated $3.5 million to the Methuselah Foundation – a life-extension-research organization that believes humans will one day live to be 1 000 years old. One of the founders argued that the first human to live a 1 000 years is already born.[260]

Only six people showed up to the lecture at Stanford. After the lecture, Levchin walked up to Thiel. They began to talk. Something clicked so they decided to meet again at the restaurant Hobee's to continue their discussion. Levchin had some ideas about what kinds of companies he wanted to found, Thiel took the bait and decided to invest in one of the ideas. "Take this idea, because this one is better, and you go start a company around it, and then I can have my hedge fund invest a little bit of money in it," Thiel said.[186]

The new company Fieldlink was born. They would later change the name of the company to Confinity – a name that originates from the words confidence and infinity.[393] But Levchin couldn't find a CEO to run the company. He didn't want to be the CEO himself because he wanted to develop software and recruit programmers. Thiel suggested he could be the CEO and Levchin could be the CTO.[186,260]

The original idea behind Confinity was to develop security software for the Palm Pilot, which was a popular brand of smaller hand-held computers. Imagine an iPhone with a black-and-white screen you can't make a call from. To interact with the screen, the user needed the same type of stylus Steve Jobs made fun of when he presented the first iPhone. "Who wants a stylus?" Jobs asked. "You have to get them, put them away, you lose them. Yech! Nobody wants a stylus. So let's not use a stylus." But it turned out that Confinity's idea couldn't become profitable. "It's really cool, it's mathematically complex, it's very secure, but no one really needed it," Levchin said. So they decided to change business idea.[186]

Changing the business idea is common when building a new company. It's known as "to pivot." You try a new idea, you kill the idea quickly if it doesn't work, and move on to your next idea. The first Sony product was a rice cooker – not a television. Nokia used to make boots and other rubber products – not mobile phones. Toyota used to manufacture automatic looms – not cars. "It's Darwinian there [in Silicon Valley] – you innovate or die." Elon said.[50]

Years before Bitcoin became a popular currency, the Confinity team discussed an idea to create a web-based currency that undermined

government tax structures.[260] But they decided to develop a software where it would be possible to store passwords and other secrets in the Palm Pilot. This idea got some attention, but they decided to pivot once again.[186]

Now they wanted to create a software called PayPal where you could store money inside of a device and transfer the money to other devices. Do you want to buy a hamburger? Bring up the Palm Pilot and beam the money to the seller of the hamburger who also needed to have a Palm Pilot. The whole process took five seconds. You could also install PayPal on your phone and pager. "All these devices will become one day just like your wallet," Thiel said. "Every one of your friends will become like a virtual, miniature ATM."[256]

To help them developing PayPal, Thiel and Levchin needed the best programmers. "This guy came in, and I asked what he liked to do for fun. He said, 'I really enjoy playing hoops.' I said, 'We can't hire the guy. Everyone I knew in college who liked to play hoops was an idiot,'" Levchin said. Most employees were introverted. They worked, read the book *Cryptonomicon* by Neal Stephenson, ate crappy food all day, and slept under their desks.[260] Levchin himself worked so much he didn't bother to go home, so he also slept in the so-called "lucky building" at 165 University Avenue. It's the same building as where companies like Google and Logitech had their first offices.[252]

When the software was ready, they launched PayPal and it was a success. The company took off with 300 new users each day. They also decided to create a website with the same functions as the software on the Palm Pilot.[186]

Several years earlier, in 1995, Pierre Omidyar created the website AuctionWeb. It was his hobby project where people could buy and sell products. But the hobby became a profitable business when Omidyar sold his broken laser pointer and realized he could charge sellers a percent fee on their sales. He contacted the winning bidder to ask if he understood the laser pointer was broken. "I'm a collector of broken laser pointers," the buyer replied. AuctionWeb belonged to Omidyar's consulting firm Echo Bay Technology Group. He tried to register the domain name echobay.com, but it was already taken. His second choice was the shorter name eBay.com.[189]

Users from eBay began asking Confinity if they could use their website PayPal to transfer money. First, they tried to tell the users from eBay to go

away because they wanted to focus on the users with Palm Pilots. Then they realized the eBay users begged Confinity to be their customers.[186]

The number of people who used Palm Pilots would be considerable less than the number of people who years later bought smartphones. But the number of people who used the website version of PayPal grew every day. While 1.5 million customers used the website, only 12 000 used the Palm Pilot version. As any entrepreneur would have done, Confinity decided to stop developing the software for the Palm Pilots, and instead go full speed ahead with the website version of PayPal.[186]

X.com and Confinity were cutthroat competitors because both companies were interested in the eBay users. In 1999, the two companies merged with each other. Almost all employees were surprised. First they worked all day trying to kill each other, and now they would cooperate with each other? X.com was the larger company because they had other services like money markets, index funds, and debit cards, but Confinity had a larger market share on eBay.

One of the reasons to why the companies merged was because both spent huge amounts of money on acquiring new users. If they combined their users, the combined company would become, according to Metcalfe's Law, four times as valuable. The second reason was that Thiel thought only one company involved in payments on the Internet could become a public company. Of the two companies, Thiel thought X.com would beat Confinity in the race to the stock market because X.com had more resources. If X.com became a public company, they would get enough resources to crush the competition. Therefore, Confinity didn't have any other choice than to merge with X.com.[189]

The strategy of the new company was that after users began using PayPal, X.com could sell to them their supermarket of financial services. Harris became the CEO, Thiel took a sabbatical year and came back to run the finance and investor divisions, and Levchin became the CTO. "I think this is going to go very well," Thiel said. "This combined company will just blow everyone else away." Elon thought the new company could become larger than the online grocery service Webvan, which had a market value of $7.9 billion.[189]

They kept the name X.com, but would later change it to PayPal because people associated X.com with pornography. Elon, on the other hand, protested against the change. He thought the name X.com was more flexible.[189]

The merged company grew very fast. The number of phone calls with customer complaints increased, and so did the complaints coming in through e-mail. “We started off with five people in customer service, and after two months we had 100 000 customers,” Elon said. “So our phone lines exploded.”[439] The solution PayPal had to solve these complaints was to ignore them by not answering the phone and by deleting the e-mails. “It took over three weeks to get my money and four calls to their 800 number, waiting an average of 25 minutes each on hold, and five e-mails of which three were answered one week later,” a customer said.[189]

Harris decided to leave X.com after only a few months and Elon replaced him as CEO. Now it was time for a technological change. While Elon wanted to replace the Unix platform with a Microsoft platform, Levchin preferred the Unix platform. By the summer of 2000, Levchin gave up and surrendered to Elon. “Well, if this is really going to happen, I’m not going to be able to provide much value, because I don’t really know anything about Windows,” Levchin told Elon. The result of this difference in opinion was a battle between the employees from the two old companies.

Most of the original X.com employees would quit. Jeremy Stoppelman was one of them. He worked as an engineer at PayPal, and would later found the company Yelp. “We had been rivals, so it was awkward,” Stoppelman said. “And that awkwardness turned into total dysfunction and warfare. Most X employees ended up leaving or getting fired. The culture was really an intellectual pissing contest, and some people didn’t like that.” But the battle between the former companies ended. PayPal realized it was a better idea to focus on the battle against other companies. eBay had by now developed a similar service called Billpoint. They also needed to win the battle against fraudsters.[260]

PayPal together with all other similar services had severe problems with fraud. In the beginning, they didn’t know they would need to take fraud into consideration. “Fraud is going to eat you for lunch,” they were told. Now they lost $10 million per month. “It was crazy,” Levchin said. One fraud ring cost them $5.7 million over a four-month period. “We can’t switch to

Windows now. This fraud thing is most important to the company. You can't allow any additional changes," Levchin told Elon.[186]

A criminal could buy stolen numbers and open fake PayPal accounts with the help of a computer program. The fraudster could then send payments through these accounts to minimize the traces from the crime. A cardholder who had lost money because of the fraud could contact PayPal and get back the money. It was up to PayPal to minimize the fraud by developing algorithms that judge the risk of each transaction. They also had 30 human investigators that tried to unravel the larger fraud cases and see if PayPal could recover some money or if they had to alert the FBI.[186,189]

One of these algorithms was IGOR, named after a Russian criminal who claimed it was impossible to catch his fraud attempts. The algorithm could find suspicious accounts and alerted PayPal if it saw money transfers that appeared to be on its way to questionable destinations.[393] Another algorithm tracked unusual patterns of behavior, such as small transfers of money to the same account at regular intervals. "If we're successful, it's like pre-crime," Levchin said. "We try to figure out what they're going to do so we can stop them before or in the act." IGOR became so good at detecting fraud that the FBI began to use it.[185]

It was in large part because of these risk-algorithms that PayPal succeeded and their competitors didn't. While another company had 25 percent fraud, PayPal claimed it had found a way to bring the fraud rate down to less than 0.5 percent.[253] And you can say that PayPal exported fraud to their competitors. Because they had so good risk-algorithms, the fraudsters gave up their attempts to fool PayPal and began fooling PayPal's competitors. "I remember all these companies announcing they were going out of business and they expected PayPal to go out of business soon too, because the fraud numbers were so staggering that they could not see any one handling this sort of thing," Levchin said.[186]

Elon went on a two-week trip to meet future investors, though other sources says he travelled to Australia to watch the Sydney Olympic Games, which would be his first vacation in years. "That's the problem with vacation," Elon said.[260] He might have been doing both. But when he

returned, a coupe had occurred, and Elon was forced out of the company. In October 2000, Thiel took his position as CEO.[71]

Because Elon owned a large share of PayPal and he remained on the board, he decided not to fight back. “Life is too short for long-term grudges,” Elon said. “One has to recognize where one’s strengths lie. It’s more interesting for me in the early stages of running a company, where the concentration is all on developing the product. I’m not really interested in administration.”[71,254]

It might look like Elon didn’t contribute with much to PayPal. But he was responsible for several of the factors that made the company so successful. According to himself, he came up with the company’s main viral growth mechanism, he recruited several of the key employees, and he came up with the business model of charging fees only to heavy sellers and not to buyers or light sellers. By the time Thiel took over the rudder as CEO, the PayPal product and business model were largely as we know them today.[259]

Before the owners sold the company to eBay in October 2002, PayPal got $180 million in funding and 20 million users. Thiel quoted the article *Earth to Palo Alto* in which the author was negative to PayPal. “And so I’d like to send a message back to planet Earth from Palo Alto,” Thiel said. “Life is good here in Palo Alto. We’ve been able to improve on many of the ways you do things. Come to Palo Alto for a visit sometime and learn something. I think you’ll find it’s a much better place than Earth.”[189] Elon, who was the largest shareholder, agreed. Life in Palo Alto was good.

As he had once again failed to change the world, Elon was still not satisfied. The large vision behind X.com had just become a small, glorified feature. It was Zip2 all over again. Still in 2012, Elon believed PayPal has the potential to become the world’s largest consumer financial services company. “It has 120 million customers, and there’s a high trust factor. There’s a lot of unleveraged value there,” he said.[71]

Most key employees left PayPal, and they are today known as the PayPal mafia. You can find a picture of them where they wear mafia suits. Thiel is considered to be the *don* [the boss] of the mafia group and Levchin the *consigliere* [the counselor].[260] But not everyone is present in the picture. The YouTube founders, Chad Hurley and Steve Chen, were not allowed to participate in the photo because the corporate handlers at Google didn’t want them to be linked to the mafia.

Elon is also missing from the photo, and the reason is simple. He missed the shoot because he received an innovator of the year award in Chicago at the same time as when the photographer took the picture.[257] "Peter [Thiel], Max [Levchin], and I are not directly aligned philosophically," Elon said. "Peter's philosophy is pretty odd. It's not normal. He's a contrarian from an investing standpoint and thinks a lot about the singularity. I'm much less excited about that. I'm pro-human. I'm also an investor in Peter's hedge fund."[259,260] Levchin agreed that he and Elon were not always aligned. "Elon is obviously really freaking smart," Levchin said. "He's one of those guys who can be larger than the room." Levchin added that larger than the room can be a negative trait.[71]

The book *The PayPal Wars* was released in 2004. "The only negativity in recent years was due to a book called The PayPal Wars, written by a sycophantic jackass called Eric Jackson," Elon said. "Eric couldn't find a real publisher, so Peter funded Eric to self-publish the book. Since Eric worships Peter, the outcome was obvious – Peter sounds like Mel Gibson in Braveheart and my role is somewhere between negligible and a bad seed. However, to his credit, Peter didn't realize the book would be as bad as it was and apologized to me personally at a Room 9 board meeting at David Sacks's home in LA."[259]

Elon, Thiel, and Levchin invested in the company Room 9, which was founded by Sacks, who had earlier worked at PayPal. Room 9 released the movie *Thank You for Smoking* – a satirical comedy on the tobacco industry. The story is as follows: "Satirical comedy follows the machinations of Big Tobacco's chief spokesman, Nick Naylor, who spins on behalf of cigarettes while trying to remain a role model for his twelve-year-old son." Elon was the executive producer of the movie, and he had a small role in the movie as a pilot of a private jet.

After this rough ride, Elon realized he had inherited the flying genes from his grandfather and father. He thought his McLaren F1 wasn't fast enough, and he didn't want to buy a group of islands, so he decided to buy a black Aero L-39 Albatros. The Albatros was an aircraft that was used to train fighter pilots in eastern Europe during the Cold War. With an airframe from former Czechoslovakia, a jet engine from Ukraine, and avionics from Russia, it was a true product of the Soviet Union.[113]

Elon used the Albatros for fun to chase other planes in the Nevada desert. "Literally, it was just like in Top Gun," he said. "You're no more than

a couple of hundred feet above the ground, following the contour of the mountains. We came up to a mountain, did a vertical climb up the side of it, inverted. Turned upside down. Yeah, that was fun. It's like a roller coaster. Only you go much farther up and down. But your butt hurts if you fly in it for more than an hour. The seats are really hard."[114]

I Don’t Need These Russians

Elon and his former housemate Adeo Ressi went on a trip to Long Island, just outside of New York. Ressi’s girlfriend and Elon’s wife were also with them.[350] Ressi was now a wealthy man after he had sold his own Internet company Methodfive to Xceed for $88 million.[46]

On the way back from the trip, they were stuck in traffic on the Long Island Expressway. The rain poured down. Elon, who by now was tired of glorified features, began daydreaming together with Ressi. “What would the next-next thing be?” they wondered. The new idea had to be something big. “I pointed my hand out the window, and I was like, ‘space,’” Ressi said. “It was almost a joke at first. We debunked the idea no one can do anything in space. The more we debunked the idea as being impossible, the more it made us interested in how we could do it. Why does it take a billion dollars? Why is it so complex? It’s just metal and fuel.”[278,301] They continued talking about space and in particular going to Mars. But Elon thought NASA already covered this area, and space also seemed too complicated and expensive.

When they came back from the trip, Elon visited NASA’s website. He searched for information on when an astronaut would set the first small step on Mars. But he couldn’t find anything on the website about the topic. “I thought there was some kind of mistake,” Elon said. “I expected to find that they were well on their way and that we’d have to figure out something else to do. But there was nothing at all.”[278]

“Hey, let’s do space,” Ressi shouted. They asked themselves why nothing had happened within the area since the last time we traveled to the Moon. “In the popular literature of the time, they expected that we would have a Moon base, a Mars base, that we would be exploring the solar system in a significant way by now,” Elon said.[57]

One problem was that we were no longer motivated by a military threat. US citizens used to be afraid of a communist base on the Moon and of nuclear weapons orbiting the Earth. A military threat motivated the earlier space programs. The early rockets were originally designed to deliver nuclear weapons and spy satellites. This threat motivated people to make sacrifices

they wouldn't have made in a time of peace. The last flight of the Apollo program occurred in July 1975, and the goal of the mission was to dock the Apollo capsule with the Russian Soyuz capsule. It marked the end of the space race between the rivaling countries. A military threat didn't exist anymore.

Another problem was that we didn't believe rockets were as exciting as we did in the 1960s. No one wanted to explore and expand beyond Earth anymore. "Spend billions of dollars to land an astronaut on Mars? What a waste of money!"

If there was no military threat and if rockets were not exciting anymore, why would we risk our lives in potentially lethal rockets and pay the money needed? "My theory was to apply the majority of my effort to the space arena, because there is not a natural economic forcing function that will lead to space exploration," Elon said.[52] As the world's oil supply decreases, the price of oil will increase, and the market will automatically motivate engineers to design machines not dependent on oil. These market forces are currently not present in space because nothing will force us to go to space unless an asteroid or a new military power threaten us.

Of the three things that in the future will most affect the future of humanity, Elon had already tried Internet two times. Since the transition to a sustainable energy economy will take care of itself, space exploration, particularly extension of life to multiple planets, needed Elon more.

Elon and Ressi needed to find a way to make space interesting once again. "We were going to show the world that two guys with money and vision could reach Mars, and that it wasn't that bad a place," Ressi said.[278] When NASA realized the public began losing interest in space, they had roughly the same idea as Elon and Ressi. To make us more interested in space, NASA decided to turn a teacher into an astronaut. The chosen teacher, Christa McAuliffe, boarded the Space Shuttle *Challenger* in 1986. 73 seconds after the launch, the Space Shuttle broke apart. All seven astronauts were killed together with our remaining interest in space.

The first idea Elon and Ressi had was to send green plants to Mars. The name of the project was Mars Oasis. With a $65 million price tag to complete the project, Elon found investors who also were critical to NASA's abilities to bring humans to Mars.[4]

The idea behind Mars Oasis was to in 2005 launch a smaller spacecraft and land it on Mars in 2006.[365] Among other equipment, the spacecraft

contained a small greenhouse with an enclosed chamber filled with dehydrated nutrient gel.[4] Different plants grew in the greenhouse, ranging from tomato plants to mustard weeds. The purpose was to test if humans could live off the land, and pictures from these plants would be transmitted back to Earth. “We’d have a great photo of green plants with a red background,” Elon said. “The public tends to respond to precedence and superlatives. This would be the first life on Mars and the furthest life had ever traveled. That would get people excited and increase NASA’s budget. If I could afford it, I figured it would be a worthy expenditure of money, with no expectation of financial return.”[63,305]

Another idea was the Life to Mars project where the green plants were replaced by mice-astronauts. “Do you think people would think I’m crazy if I sent mice to Mars?” Elon asked his friends.[59] With the purpose to see if mice could breed in an environment similar to the environment on Mars, the mission would last for six weeks. But the rodents didn’t have to worry about landing on a planet. To simulated the gravity on Mars, they lived in a rotating craft up in space.[287]

While NASA’s space missions focuses on geological research, the theme of these different projects by Elon and Ressi was to see if humans could live on Mars. “The public could get excited about it, and that would result in funding from NASA and an imperative to take things to the next step,” Elon said.[57]

But Elon and Ressi were no space engineers, so they needed help. In August 2001, one month after they came up with the idea to do space, Elon contacted the aerospace consultant Jim Cantrell.

“I had the top down on my car, so all I could make out was that some guy named Ian Musk was saying that he was an Internet billionaire and needed to talk to me,” Cantrell said. “I’m pretty sure he used that phrase, ‘Internet billionaire.’ I told him I’d call him back when I got home, but when I called, I got a fax machine. I said, ‘Sure, Internet billionaire.’ Then my phone rang. I asked him what was with the fax machine.”

“I don’t want you to know my cell number,” Elon replied. “I want to change mankind’s outlook on being a multi-planetary species. Can we meet this weekend? I have a private jet, I’ll fly to your house.”

“No, I’ll meet you at the airport in Salt Lake,” Cantrell replied. He wanted to meet in a secure environment where Elon couldn’t bring a weapon.

After the meeting ended, Cantrell wasn't suspicious anymore. Cantrell decided to help Elon to put a team together and see how much the project would cost.[278] They talked to contractors who could build the Mars Oasis for a comparatively low cost. But to fulfill the mission they needed more than one rocket, or launch vehicle in aerospace-industry parlance. If the first rocket failed, they wanted to be on the safe side and be able to launch another rocket.[288]

The cheapest American rocket was Boeing's Delta II. With a launch cost of $50 million, they thought it was too expensive. So they began a global hunt for cheap rockets. "We went everywhere: France, small private contractors in Russia, the Pasadena Jet Propulsion Lab, the people who have the X Prize," Ressi said.[60]

In France, they met with Arianespace – the European organization that launched several of the world's satellites. "We rented the penthouse suite of one of the major hotels in Paris, across from the Louvre," Ressi said. "We had the whole top floor, usually rented by the sultan of Brunei or something. Elon and I invited all our friends. It was basically about sixty hours of meetings and thirty hours of partying."[278]

One peculiar thing Elon learned in Paris was that you first might think all the women are good looking. "Actually if you look carefully, they aren't really so good looking, they just think they are," Elon said. "They walk proudly, dress with style and act as if they own the world. Women are lucky, they can make themselves look better. We [men] have to settle for the way we look."[81,115]

It turned out also the European rockets were too expensive, so they decided to head east. In 2001, they began traveling to Russia to negotiate if they could use the Dnepr rocket, named after the Dnepr river. The Dnepr was a converted Russian SS-18 Satan intercontinental ballistic missile developed in the 1960s. An intercontinental ballistic missile is typically designed to deliver one or more nuclear weapons and each Satan could deliver ten nuclear warheads. "It was very weird going late 2001-2002 to Russia and saying 'I want to buy two of your biggest rockets, but you can keep the nukes,'" Elon said. "They thought I was crazy, but, I did have money. So, that was okay."[63]

The Russian economy collapsed in 1998, so the economy was even worse than after the dissolution of the Soviet Union in 1991. "This was when it was still the Wild West over there," Ressi said. "I mean, there were like

dead people on the side of the road. We got pulled over multiple times, at gunpoint, and had to bribe the police. No reason. Just 'Give us money.'"[278]

They went through several negotiations at secret locations, including a negotiation with a general, who had lost a front tooth, in a room with padded walls. As you may suspect, they had to consume vast amounts of vodka during these negotiations. "We'd all go in this little room and every single person had his own bottle in front of him," Ressi said. "They'd toast every two minutes, which means 20 or 30 toasts an hour."

"To space!"

"To America!"

"To America in space!"

"I finally looked over at Elon and Jim and they were passed out on the table. Then I passed out myself."[278]

The Russians also visited them in Los Angeles. "We can't continue unless you give us $5 000 in cash," the Russians demanded. Elon and Ressi heard this on a Saturday because the Russians needed money for a wild night out. But how do you come up with $5 000 in Los Angeles on a Saturday? Fortunately, Ressi knew the manager of a hotel, and he told the manager they needed all the cash the hotel had.[278]

Before the last visit to Russia, Ressi had become tired of the Russians and remained home. Elon traveled on his own with $21 million to buy three rockets. When he arrived, the Russians had changed their mind. Now they wanted to sell only one rocket for $21 million. Elon argued with them. "Oh, little boy, you don't have the money?" one Russian replied, and Elon thought it was time to begin looking elsewhere for rockets.[278]

These trips to Russia affected Elon in a traumatic way. "I would pay 20 million dollars not to spend six months in Russia," Elon replied when asked if he wanted to travel to space as a space tourist with a Russian rocket.

It was perhaps just as well the deal with the Russians didn't happen. Elon realized a deal would be too risky since it involved several parties across different countries. The Russians owned the rocket, but they had to ship it to Ukraine for refurbishment and conversion to launch vehicle. Then they had to ship it back to Russia and towards Kazakhstan where the launch took place.[365] Kazakhstan used to be a part of the Soviet Union and is the home of the Baikonur Cosmodrome base where all the Russian historical rockets launched. When the Soviet Union dissolved, it was too expensive to move the base to Russia, so the Russian government leases it until 2050.

If one of these parties was delayed, the entire mission had to be postponed 26 months. When you launch a rocket to Mars, you want the shortest possible travel distance from Earth to Mars. The distance to Mars from Earth is constantly changing because Mars and Earth orbit the sun at different speeds. Earth is closer to the Sun and gets around the Sun more quickly than Mars, and both planets have elliptical orbits. Because of these factors, you have a launch window of one month every 26 months.[365,395]

"I think we can build a rocket ourselves," Ressi said.[278] Elon had thought this thought before. He wondered why they had to buy rockets from Russia when we don't buy anything else from Russia – except Vodka. "If you look at Russian rocketry, since the fall of the Soviet Union, there's really been no significant developments," Elon said. "The technology has barely progressed."[351] Why were the Russian rockets so cheap? Elon did some engineering calculations.[364] "I looked at it and said, I'll be damned – that's why he's been borrowing all my books," Cantrell said. "He'd been borrowing all my college textbooks on rocketry and propulsion. You know, whenever anybody asks Elon how he learned to build rockets, he says, 'I read books.' Well, it's true."[278]

They realized that the only reason why the Russian rockets were less expensive compared with the US rockets was that the Russians had already manufactured them. If they needed more rockets, the Russians had to build new rockets where each one became more expensive compared with those already manufactured. "I don't need these Russians," Elon said.

The problem wasn't that mankind didn't want to go to space – the real problem was that it was too expensive. And without an existing threat, we didn't want to spend the money. "I came to the conclusion that my initial impression was wrong about not enough will to explore and expand beyond Earth and have a Mars base," Elon said. "That was wrong. There's plenty of will, particularly in the United States. Because United States is the nation of explorers, people came here from other parts of the world. The United States is a distillation of the spirit of human exploration. If people think it's impossible and it's going to break the budget, they're not going to do it."[63,278]

Elon wasn't the first to understand that the major problem with space was the costs involved. To attack this problem by finding cheaper solutions, the X Prize Foundation established numerous competitions.

Google Lunar X Prize is one of these competitions, but the most well-known was the Ansari X Prize. If you were a non-government organization and could launch a reusable manned spacecraft into space twice within two weeks, you would get a $10 million reward. The name Ansari originates from Amir Ansari and Anousheh Ansari who donated a larger sum to the competition. Other donors included Elon himself. Anousheh became the first self-funded woman to visit the International Space Station as a "spaceflight participant" – not a "space tourist" as she explained. SpaceShipOne won the price in 2004.

PayPal became a public company in February 2002. After the first day, the stock had increased by almost 55 percent. Elon, who was one of the largest shareholders, had now more financial resources, so Space Exploration Technologies [SpaceX] could be founded in June 2002. The idea behind SpaceX was to manufacture cheap rockets with the ultimate goal to colonize Mars. While the Concorde commercial said, "The world is now a smaller place;" the SpaceX commercial will say, "The universe is now a smaller place."

There's a saying in the rocket industry that the easiest way to become a millionaire is to start with a billion. "I was trying to find the fastest way to turn a large fortune into a small one," Elon said. "I thought the rocket business was perfect."[415]

To discourage Elon to found SpaceX, one of his friends compiled a video tape with failed rocket launches he made Elon watch. "Elon, you cannot start a launch company. This is stupid," everyone told him. "I'm going to do it. Thanks," Elon replied. SpaceX had a controversial business idea, thus it's not strange his friends were negative. History is filled with similar examples.[29]

> "This telephone has too many shortcomings to be seriously considered as a means of communication."
>
> "The wireless music box [radio] has no imaginable commercial value. Who would pay for a message sent to nobody in particular?"
>
> "While theoretically and technically television may be feasible – commercially and financially it is an impossibility."

“Sorry Steve [Jobs], here’s why Apple Stores won’t work.”

Also Elon can be negative to new business ideas. When Twitter wasn’t as big as it is today, Elon didn’t believe in the 140-character-messages. His wife was a Twitter addict. When he wandered by and looked at the stream of tweets on her screen, he said, “I don’t really get it.”[144] Elon would later join Twitter and has now around 740 000 followers. His first tweet to the world was “Please ignore prior tweets, as that was someone pretending to be me :) This is actually me.”

Despite the negative thoughts from everyone around him, Elon knew the world needed a company like SpaceX. Perhaps he remembered a quote by his role model Walt Disney who said, “It’s kind of fun to do the impossible.” Disney knew what he talked about - when he decided to build Disneyland, everyone thought it would end up as closed and forgotten within the first year. “My rationale there was that it was an important enough cause – at least to me – that it was worth putting funds at risk and possibly losing them,” Elon said. “Failure is an option here. If things are not failing, you are not innovating enough. The reason I’m doing SpaceX is not because I think this is the highest return on investment. I think starting a rocket company is an unusual thing to do and pretty risky. But I’m a big believer in us becoming a space exploring civilization.” He never asked what his wife thought of the idea to start a rocket company.[128,278,354,410]

After founding SpaceX, the first thing Elon did was to spread the word how he would build rockets with the ultimate goal to colonize Mars. He talked to magazine writers, movie stars, and wealthy entrepreneurs. The reason why he did it is simple. He thought no one would sell him any rocket parts if they didn’t believe he was serious about the idea to build rockets.[278]

SpaceX opened an office in El Segundo, Los Angeles, because southern California has the highest density of aerospace engineers in the world. Elon assumed experienced space engineers didn’t want to move to San Francisco. “They [his friends] view southern California as being a little vacuous and northern California as being more intellectual,” Elon said. “But people in the Bay Area have forgotten that there’s been a huge concentration of aerospace engineering talent here, for more than a century. In Silicon Valley, startups are such a norm, and there are many success stories. In southern California that’s not so much the case. In the early days of aviation, southern California

was startup city. This was the huge entrepreneurial center."[316] SpaceX was Elon's only company, so he decided to move from his current home in Palo Alto to Los Angeles.

Elon became the CEO of SpaceX, and because he didn't find any CTO to hire, he also became the CTO. Initially, Elon wanted to hire someone as the chief designer of the rocket, but he couldn't find anyone who was willing to join and was competent. Those who were willing to join couldn't do the job and those who could do the job weren't willing to join. "A lot of aerospace senior managers seem to be really disassociated from and unable to do hard core engineering," Elon said. "I think that is a mistake and results in cloudy judgment on important technical issues – they can't tell if something is really good or not, so they just do what everyone else does, assuming it to be the safe bet."[285]

It would be has hard to find a good CEO if Elon needed to replace himself. "Jeff Bezos could do this [be CEO of SpaceX]. Larry Page could do this. Bill Gates could do this. But there's just a really small list of people with the sufficient technical and business ability to do this job," Elon said.[71]

The original SpaceX team consisted of about 20 SpaceXers, as they call themselves. It was a small, but efficient team. "I think it is a mistake to hire huge numbers of people to get a complicated job done," Elon said. "Numbers will never compensate for talent in getting the right answer [Two people who don't know something are no better than one], will tend to slow down progress and will make the task incredibly expensive."[285]

To find a great team, Elon didn't cold-call different experts. Because almost all other private rocket companies had failed, the experts didn't want to join yet another company that eventually would fail.[365] "It would have been quite difficult if I'd just started off by cold-calling them and saying that I wanted to start a rocket company," Elon said. "What I said was 'Would you mind helping me with a feasibility study to find out if it's possible to make significant advancements in rocket technology? It will involve a few weekends and evenings of your time, I said I'd pay a decent amount for their help, and so they were enthusiastic."[128]

A graveyard with failed rocket companies include VolksRocket, AMROC, and Beal Areospace. The reasons why these companies failed were: they didn't have the technical knowledge needed, they had insufficient capital, or they relied on technologies that didn't yet exist. SpaceX, however, recruited experienced engineers, had enough capital to afford the loss of

several rockets, and was founded in the 21st century. “The design tools, such as solid modeling and finite element analysis software are substantially more powerful than ten years ago, so that’s a clear advantage,” Elon said. “Obviously, most electronics have improved a lot too, except gyroscopes and flight termination systems.”[285]

After the meetings ended, they concluded it would indeed be possible to build better rockets than those built before. The experts were now convinced that SpaceX was different and wouldn’t end up as yet another failed rocket company. “I essentially led them to a conclusion that they created,” Elon said. “It was sort of a Socratic dialogue on a technical level. The essence of a Socratic dialogue is that people wind up convincing themselves. People are much more willing to change their opinion if you’re not forcing it.”[128]

Convinced experts from companies like Boeing, TRW, Google, and Microsoft joined SpaceX. “It was a can-do attitude combined with the fact that he knew what he was talking about and was happy to be corrected if he didn’t. You couldn’t say no to it,” an expert said.[49]

But Cantrell, the expert who had helped Elon from the very beginning, wasn’t convinced. “What separated us, I believe, was his lack of even being able to conceive failure,” he said. “I know this because this is where we parted ways at SpaceX. We got to a point where I could not see it succeeding and walked away. I have 25 years experience building space hardware and he had none at the time. So much for experience.”[457]

Employee number seven was Gwynne Shotwell, who joined SpaceX in 2002 and is now working as the company’s President and COO. Since the day she asked her mother how an engine worked, she has been interested in technology. “So my mom bought me a book on engines,” she said. “I read it and became really interested in car engines, and gears and differentials.”[309] As one of the few women in a primarily male industry, she hasn’t experienced any disadvantages of being a woman. “I did have a little problem during an interview process – but I didn’t get that job because I was a girl – but they were clearly losers, so it is best that I didn’t work for them,” she said. “What counts is how effective you are, not what body parts you happen to possess.”[310]

SpaceX needed not only experts with years of experience – they also needed young people who didn’t have any limits. If you have years of experience from a company, you may have learned it’s impossible to build cheaper rockets. But if you have no experience, you do not yet know what’s

impossible, then it's much easier to do what everyone else think is impossible. To find these new engineers, SpaceX contacted Stanford University´s aeronautics and astronautics department to get the names of the best students. "We start with that layer – young engineers, young talent, young technicians – who don't really know what's impossible," a SpaceXer said.[425]

As when Elon founded X.com and Zip2, he didn't have any practical experience from the industry. Launching rockets as a kid in South Africa wasn't enough. But the degree in physics included some basic theories he could use, and he was eager to learn what he didn't know by reading books and through learn by doing. "It is not like I ever worked for Boeing or Lockheed," Elon said. "But I do have an understanding of how things work in physics and engineering."[60]

Elon set out to learn everything he could about rocket technology by asking his employees who were experts in their respective area. "I'd never seen anything like it," a SpaceXer said. "He was the quickest learner I've ever come across. You had this guy who knew everything from a business point of view, but who was also clearly capable of knowing everything from a technical point of view – and the place he was creating was a blank sheet of paper."[49]

It took Elon two years to learn what he needed to know about rockets. "I know my rocket inside out and backward," he said. "I can tell you the heat treating temper of the skin material, where it changes, why we chose that material, the welding technique… down to the gnat's ass."[288]

Henry Ford always said there are no big problems; there are just a lot of little problems. "Ford was just the kinda guy that when something was in the way, he just found a way around it," Elon said. To solve the problem of why it was so expensive to launch rockets, SpaceX had to break it down into smaller questions.

The first question the SpaceX team had to answer was whether they should build a capsule on the top of a rocket or a new Space Shuttle. Arguing the Space Shuttle should have retired ten years earlier than it did, they came to the conclusion a capsule was the best alternative.[53] The idea behind the Space Shuttle might have been sound, but in reality it had several drawbacks.

“The Shuttle is just an incredible complex and dangerous machine,” Elon said.[365]

The Space Shuttle didn’t have an escape module that could save the crew if something went wrong after the launch. As *Titanic* would never sink, the engineers who constructed the Space Shuttle decided it didn’t need an escape module because it would never fail.[350] “It [the Space Shuttle] really is not a good design,” Elon said. “It is something where if anything goes wrong, the crew dies. And that is no good. We were much better off with the Apollo approach [a capsule] where if something went wrong with the booster, you had an escape module.”[365] The idea behind an escape module is similar to an ejection seat in a military aircraft. If something happens after the launch, the escape module will make it possible for the astronauts to fly away from the rest of the rocket. It will probably save the crew.

An often-used argument in favor of the Space Shuttle was that it could land wherever you wanted it to land as long as the runway was long enough. The other alternative, a capsule, will just fall into the ocean and then the navy has to search for it with aircraft carriers. But it’s a misconception. A capsule returning from space with a parachute can steer on the way down since the capsule itself has similar properties as a wing. Years before GPS became available, latter capsules from the Apollo program could land within a circle with a radius of 1 mile [2 km]. When you land a capsule, the only factor you can’t control is the wind. To correct for the wind, it’s possible to add a different type of parachute or a propeller. Now you can land with a capsule on the painted numbers on a runway in a similar way as when a skydiver can land with a high accuracy.[350]

SpaceX’s long-term goal is to land on other planets, such as Mars, thus there’s no point with the Space Shuttle’s wings since there are no runways on Mars. “In space, wings are dumb. You don’t make an aircraft looking like a boat,” Elon said.[350] Despite having wings, the Space Shuttle couldn’t really fly. It could only fall with style. When it returned from space, it glided towards the runway without any engines, so it had only one chance to land.

Yet another drawback with the Space Shuttle is that it was designed to be reusable, but in reality, it wasn’t. After each launch, the external tank broke up before impact in the sea and was never recovered. The reusable parts were so difficult to reuse that the cost of the Space Shuttle was four times more compared with an expendable rocket with equivalent payload capability.[305]

The second question the team had to answer was whether they should rebuild an existing rocket or design a new rocket from a clean sheet. What if SpaceX could rebuild the old Saturn V rocket that launched the craft used when we landed on the Moon. Elon argued the Saturn V was a great rocket and its design was much better compared with the Space Shuttle.[350] "The holy grail of SpaceX would be to build the Saturn VI," Elon said.[365]

Finding old Saturn V blueprints wasn't an issue. A rumor circulated that the blueprints for the Saturn V rocket were lost, or rather destroyed by the US government so they wouldn't fall into the wrong hands. But the rumor proved to be false. The blueprints for the Saturn V rocket exists and are stored at the Marshall Space Flight Center and at the Federal Archives. Rocketdyne, the manufacturer of the large F-1 and smaller J-2 engines used in the Saturn V, have also saved their blueprints.[279]

The problem with rebuilding the Saturn V rocket is that it was designed in the 1960s. It's impossible to reproduce the rocket because the parts are not manufactured anymore. To rebuild the Saturn V, it has to be redesigned with modern parts, and in the end it's easier to design a completely new rocket.[279] And that's what the engineers at SpaceX set out to do.

The rockets designed by SpaceX had to be cheap. We want to explore and expand beyond Earth and have a Mars base if we can afford it. Launching a rocket is easy compared with how to do it cheaply. You can compare SpaceX with Henry Ford who didn't invent the car - he just made it available to the public by designing the cheap and reliable T-Ford.

A rocket with a capsule can be more expensive than a Space Shuttle. After the Space Shuttle accident in 2003, when *Columbia* disintegrated during re-entry into the Earth's atmosphere, the US government ordered the development of the Ares I rocket. "As is not unusual with large government programs, the schedule slipped and costs ballooned by tens of billions," Elon said. President Barack Obama canceled the new rocket because it didn't make sense anymore. To finish the rocket, the program would have needed another $50 billion and the cost per flight would have been $1.5 billion. The cost per flight with the Space Shuttle was $1 billion. This is despite the fact that Ares I could carry only four astronauts and the Space Shuttle could carry at least seven.[277]

To come up with the answer why rockets were expensive, Elon used his engineering skills. "I tend to approach things from a physics framework," Elon said. "And physics teaches you to reason from first principles rather

than by analogy. So I said, OK, let's look at the first principles. What is a rocket made of? Aerospace-grade aluminum alloys, plus some titanium, copper, and carbon fiber. And then I asked, what is the value of those materials on the commodity market? It turned out that the materials cost of a rocket was around two percent of the typical price – which is a crazy ratio for a large mechanical product."[305] In comparison, the price of the material in a car in relationship to the price of the car itself is about 25 percent. Neither rocket fuel was the reason to why rockets were expensive. The cost of the fuel and oxygen used in a modern rocket is about 0.3 percent of the price.

If neither material nor rocket fuel could be blamed as the reason to why rockets were so expensive, what was the real reason? When SpaceX was founded, Boeing or Lockheed manufactured most rockets. Their rockets were far from cheap simply because they never needed to cut the costs. The rockets were partly funded by the US government, and if the rockets became more expensive than what the contract with NASA said, they received more money. Rockets that are more expensive were actually something good. "If you were sitting at an executive meeting at Boeing and Lockheed and you came up with some brilliant idea to reduce the cost of Atlas or Delta, you'd be fired," Elon said. "Because you've got to go report to your shareholders why you made less money. So their incentive is to maximize the cost of a vehicle, right up to the threshold of cancellation."[288]

On the other hand, Skunk Works, a division of Lockheed and famous for aircraft like F-117 Nighthawk and SR-71 Blackbird, gave back money to the government. They gave it back either because they had brought in a project under budget or because they saw that what they worked with was just not going to work.[407]

SpaceX's plan was now complete. They would design a rocket with a capsule on the top. To lower the price per launch, all parts of the rocket had to be reusable within a matter of hours – not months as with the Space Shuttle. SpaceX needed to avoid the mentality of other companies that design expensive rockets just to make more money from the government. "Our first order of business is to defeat the incumbent, old school rocket companies," Elon said. "Lockheed. Boeing. Russia. China. If this is a chess game, they don't have much of a chance."[50]

Launching a Truck Into Space

SpaceX set out to build the cheap and reliable T-Ford rocket. The Falcon Explorer was the result of their hard work, but they would later change the name to Falcon 1. As the number 1 indicates, the Falcon 1 would be the first in a series of rockets named after the spacecraft *Millennium Falcon* from the *Star Wars* movies.[299] The main character in the first trilogy, Luke Skywalker, called the ship "a piece of junk" when he first saw it. "The ship may not look like much, but she's got it where it counts," the captain of the *Millennium Falcon*, Han Solo, told Skywalker.

Neither Falcon 1 looked like much. SpaceX designed the rocket to have the same performance as a reliable truck. "Think of cars, is a Ferrari more reliable than a Toyota Corolla or a Honda Civic?" Elon asked. "Current rockets are designed to have ultra-high performance, often to the point of far exceeding the thrust needed to get the job done. Right now, a lot of rockets used to launch satellites are former missiles. The way the launches work, it's as if when you boarded a commercial jetliner you knew that should any of the engines fail, you'd crash and die. Would you get on board?"[288,289,311]

But it wouldn't be cheap to design the truck. SpaceX needed much of the initial capital together with government funding – approximately $100 million.[280] The total number of employees were now 150 SpaceXers.

While the Saturn V from the Apollo program was a three-stage rocket, the Falcon 1 had only two stages. You split a rocket into stages to save weight. After the launch, and when the first stage has run out of fuel, it will separate from the second stage and fall back to Earth. The engines attached to the second stage will now start and power the rest of the rocket up to space. While the first stage of the Falcon 1 rocket had a speed of 6 850 mph [11 000 km/h], the second stage had a speed of 17 000 mph.

To find the engines needed to power the rocket, Elon contacted Tom Mueller. He was a member of the Reaction Research Society – a group of amateur rocket enthusiasts. They launched rockets on a dry lakebed at the edge of the Mojave Desert. But Mueller was no amateur. He had joined the

group to do all the crazy stuff he wasn't allowed to do at his job as a rocket engineer.[278]

Mueller's life story resemble the same story as shown in the movie *October Sky*. The movie tells the true story of Homer Hickham, who grew up in a coal mining community. Hickham was inspired by the launch of the Russian satellite Sputnik 1 and decided to become an engineer despite his father's negative thoughts. His father wanted him to become a coal miner, but Hickham didn't listen to him and would eventually become a NASA rocket scientist. The only difference from the movie is that Mueller grew up in the small logging community St. Maries, Idaho.

The young Mueller built and flew hobby rockets. "I'd buy them at the local hobby shop," he said. "I made dozens of those things. I had them hanging above my bed and on the shelves around my bed. Of course they didn't last long because I'd always lose them or crash them or blow them up or something." One of the rockets carried a load of crickets. Mueller wanted to see the effect of acceleration on the unsuspecting creatures.[317]

Mueller's dream was to become an aircraft mechanic. But during his first year in high school, his math teacher asked him why he didn't want to become an engineer. Why was his dream to be the one who fixes the plane and not the one who designed it? "If it hadn't been for that math teacher, I probably would have been a mechanic or a logger," Mueller said. "Thanks to him, I got the right courses to go to college. And instead, I went off to be an engineer."[318]

After a brief visit to California, Mueller knew he one day would come back and work with rockets. But first he needed to attend engineering school. During the summer breaks, he worked as a logger. The work was exhausting. "I knew that I did not want to do that for the rest of my life," Mueller said. "Because that was the alternative – I either get through college and become an engineer or I'm going to become a logger like the rest of my family. That was very, very motivating. I'd be out there in the bugs and the sticks working and sweating all summer. And I'd just think about, when I get back to school, I'm going to study so hard."[317]

After graduation, Mueller moved to California and began working for TRW. Founded in 1901, TRW had worked on the first American ICBM and the engine for the Apollo lunar lander that helped Neil Armstrong and the other astronauts to land on the Moon. Mueller had now designed a prototype

rocket engine in his garage. One day, he got a telephone call from a space entrepreneur.

"How much do you think we can get the cost of an engine down, compared to what you were predicting they'd cost at TRW?" Elon asked.

"Oh, probably a factor of three," Mueller replied.

"We need a factor of ten," Elon said.[288]

Elon asked him if he could get the prototype engine to fly. Mueller replied that he could if he had a team with skilled engineers. Elon hired him and Mueller decided to leave his job at TRW. "I had several other opportunities, but when Elon approached me I could see he was different," Mueller said. "The others always had a gimmick, like a helicopter blade or some miracle technology. Elon just wanted to take the best technology already out there, build a simple vehicle and use the right propellants."[307]

For fourteen years, Mueller worked for TRW and can now compare the differences between TRW and SpaceX. It took him and 80 other engineers five years to design an engine intended for the Delta IV rocket, but Boeing decided to choose another engine. All the money and resources used to develop the original engine were wasted. "I can't think of anything I was responsible for at TRW that ever flew," Mueller said.[71]

At SpaceX, Mueller developed a rocket engine together with a team of only 25 engineers. They got the cost of the engine down by a factor of ten, as Elon had demanded, but it was a difficult challenge. "I don't know if there's a single thing in that engine that has worked," Elon said about the early prototypes of the rocket engine. "Where do I start? The turbo pump has been difficult, the thrust chamber assembly's been difficult, and all the little stuff in between has been difficult, too."[301]

Known as the Merlin, the engine developed by Mueller's team became the first rocket engine produced by an American company in 10 years and the second rocket engine in 25 years. It seems probable that the name originates from the bird Merlin – a small species of falcons. "The Merlin is much more analogous to a truck engine than a sports car engine, which is how all other engines are designed," Elon said. "Instead of designing it to the bleeding edge of performance and drawing out every last ounce of thrust, we designed Merlin to be easy to build, easy to fix and robust. It can take a beating and still keep going."[303]

The Merlin is not an engine that cares about the environment, but that's not an issue. "You know, rockets contribute, essentially, 0.000001 percent of

CO2 or other emissions," Elon said. "And unfortunately, you really need to burn chemical propellants to get out of Earth's gravity. There's no other way to do it."[4] An electric rocket creates thrust by accelerating beams of ions. These rockets are efficient, but the amount of thrust they produce is very small compared to the amount produced by chemical propulsion. Because of the low thrust, you can't use ion thrusters to launch a spacecraft into orbit, but ion thrusters are ideal for propulsion when the spacecraft is in space.[294]

To test the rockets, SpaceX needed a test facility. They couldn't test rocket engines in downtown Los Angeles. Just south of Dallas, in McGregor, Texas, they found a perfect facility. SpaceX bought the site from the Texas banker Andrew Beal, whose own rocket company, Beal Aerospace, had used the site.

In 2000, Beal shut down Beal Aerospace because it was too difficult for a private company to compete with the governmental subsidies of NASA. He explained that the problems for space entrepreneurs are more political than technical. Elon agreed with him. "The Pentagon's preferred approach is to do long-term, 'sole-source' contracts – which means to lock up the entire business for one company," Elon said. "We've been trying to bid on the primary Air Force launch contract, but it's nearly impossible, because United Launch Alliance, co-owned by Boeing and Lockheed Martin, currently has an exclusive contract with the Air Force for satellite launch. It's totally inappropriate. Even though we would save the taxpayers at least a billion dollars a year – and that's a conservative estimate."[305]

SpaceX assemble all Merlin engines in Los Angeles and test-fire them in Texas. One part of the test involves feeding a stainless steel nut into the fuel and oxidizer lines while the engine is running. Another test is performed on the launch pad and yet another just before liftoff. For a while after the engines are ignited, the rocket can't ascend because it's held down by clamps so Falcon's computers can analyze the engine performance. When everything looks good, the clamps are released and the rocket can fly away.[288]

To avoid the risk of getting loose nuts in the engines, SpaceX minimized the number of parts in each rocket. "They've designed a solution, but it's not a good solution, because it's got several hundred parts," Elon said about an early design of a propellant tank. "If any of those pieces shake loose, they'll get stuck and choke the engine. And that will really suck."[71]

SpaceX designed Falcon 1 to deliver a payload of 1 000 kg into low Earth orbit, which is the space below an altitude of 1 200 miles [2 000 km]

and above 99 miles [160 km]. The rocket could also deliver a lighter payload beyond low Earth orbit into cislunar space, which is the space between the Earth and the Moon. Cislunar is Latin for “on this side of the moon” but also “not beyond the moon.” Beyond the cislunar space is the translunar space.[280,380] Launching a rocket to low Earth orbit is the most common altitude. It’s where the International Space Station circulates at a height of 250 miles [400 km], and it’s where the majority of the satellites are.

Like a new car, SpaceX unveiled the Falcon 1 just outside of the National Air and Space Museum in Washington DC. SpaceX brought the entire seven-story high rocket together with its mobile launch system. This was in December 2003, so the event coincided with the first flight of the first aircraft, which flew for the first time in December 1903. Falcon 1’s maiden voyage should have coincided with the 100th anniversary of this first flight, but due to delays, the rocket had not yet launched.

Elon made a statement during this event. “We’re very proud to debut this vehicle, and do so here in DC,” Elon said. “Another thing I want to do here is to announce what the follow-on is to the Falcon, called the Falcon 5. Falcon 5 will be the first US launch vehicle with true engine-out capability in over three decades, since the Saturn V. We can have multiple engines fail, depending on the phase of flight, and still have a successful mission. We think that will really have a dramatic improvement in the reliability of access to space.”[312]

SpaceX decided to launch Falcon 1 from the Vandenberg Air Force Base. They leased a launch pad from the Air Force, transported the rocket to the launch site, got the rocket in place, and they test-fired it. They were ready. But they were not allowed to launch. The Falcon 1 would fly over a Titan IV rocket with a billion dollar payload, so there was a small risk the Falcon 1 could destroy the Titan IV if something happened after the launch. “It’s like you build your house… somebody else builds a house next to you and tells you to get out of your house. Like, what the hell… after we’ve made that big investment and everything,” Elon shouted and decided to find another launch site.[301,365]

You can find a picture of Elon where he holds a white cat. Like a James Bond villain, SpaceX decided to launch the Falcon 1 from one of the Marshall Islands in the South Pacific, 2 100 miles [3 400 km] southwest from

Hawaii. The name of the launch site is the Reagan Test Site at the Omelek Island, which is a part of the Kwajalein Atoll. Known as the *Execution Island* during the Second World War, the atoll is today often called just Kwaj. The area is military ground. You can see a large concrete building previously used as a target for laser beams from space, and a part of the atoll is a target for testing missiles launched from the US mainland.

Several visitors attended the first launch. You could see representatives from government agencies and corporations. Someone who also visited the launch was Elon's brother Kimbal. He said that physics is fun, but Elon suspected what his brother really liked was to visit exotic islands in the south pacific and fly Huey helicopters.

The island leased by SpaceX used to be a launch pad during the Cold War. When SpaceX arrived to the island, they had to cut down the overgrown bushes and trees. Then they poured concrete to build a launch pad.[284]

They were ready to launch Falcon 1. Due to safety reasons, the drawback with this launch site was that the launch pad wasn't on the same island as where the SpaceXers were. When sensors on the rocket detected a glitch, the launch team had to make a 20-minute boat trip to fix the problem. SpaceX hadn't anticipated this delay, so they hadn't stockpiled enough liquid oxygen on the island. Liquid oxygen is used as a fuel component and to cool the rocket's helium supply. The launch had to be postponed until they could import more liquid oxygen from Hawaii.[301]

Another problem occurred when they discovered that not all rocket components were operating properly. The malfunctioned components needed to be upgraded. While the rest of the team tried to find a supplier who hadn't closed on a Sunday, a SpaceXer took a plane from Kwaj back to SpaceX in Los Angeles. They found a supplier in Minnesota, so an intern from SpaceX in Los Angeles had to fly there to get the components. The intern got back to Los Angeles where they tested the new parts before they flew them to Kwaj. "The SpaceX launch team in Kwaj is less than 30 people," Kimbal said. "When another rocket company launches in Kwaj, they bring 300 people. What they do is beyond us."[283]

When the rocket finally launched in March 2006, it flew for 33 seconds before the flight ended abruptly. The load, an experimental satellite from the US Air Force Academy, came crashing down through the roof of SpaceX's machine shop, landing mostly intact on the floor.[281] "Everyone was cheering," Mueller said. "But my engine went on fire. It burned through the

wires, and the data was terrible. 33 seconds in, it flamed out and Falcon fell a mile back onto the reef. We lost everything, all data, everything. There was the jubilation of it lifting off and the agony of it crashing. It was a pretty unpleasant time to be hanging with Elon."[278]

SpaceX released an official video showing the crash. It's possible to see how the white rocket begins to turn due to a fuel leak, before it finally crashed on a reef close to the launch site. To figure out what went wrong, Elon and his team had to spend the rest of the day collecting scattered pieces of the rocket. "I was picking up bits of rocket at the launch site," Elon said.[63] After several months, the SpaceX engineers determined a corroded nut had permitted fuel to leak, the fuel caught fire, and the rest is history.

The second launch was supposed to happen in January 2007, but was delayed until March 2007. Falcon 1 flew to an altitude of 180 miles [290 km], before it failed to reach orbit. It's possible to see on the launch video how, after 2 minutes and 50 seconds, the rocket separates as it was supposed to, and how the first stage falls back to Earth. The first stage could never be found again due to a broken GPS transmitter. The reason why Falcon 1 failed this time was that an engine had stopped 90 seconds too early.

The Electric Stars

There was a time when more electric cars drove on the roads than there were cars powered by fossil fuels. In 1900, electric motors powered 34 percent of the cars in New York, Boston, and Chicago. A steam or a combustion engine powered the other cars.[385]

Manufactured in the late 1800s, the first electric cars were quiet, clean, and could be charged in the home.[59] The torpedo shaped electric car, *The Never Satisfied*, was the first vehicle to reach a speed over 62 mph [100 km/h]. Those who saw the record thought they were going to die if they traveled so fast. While Henry Ford mass produced gasoline cars, his wife Clara Ford drove a 1914 Detroit Electric with a range of 80 miles [130 km] and a speed of 20 mph [32 km/h].[218]

Around 1920, the gasoline cars began to outnumber the electric because they were easier to refuel. In most smaller towns in America, the gasoline car arrived before electricity. The gasoline car was also less expensive. You could buy three of Ford's Model T for the price of just one electric car.[59,329] Several car manufacturers have since then again and again tried to sell electric cars. But all models failed. They didn't always fail because the cars were expensive, slow, ugly, or had a limited range – they could also fail because the auto manufacturers wanted them to fail. The best example is General Motors's EV1.

At the 1990 Los Angeles Auto Show, General Motors revealed an electric concept car: the Impact. Because of the name, you could hear comments like, "What's next, the Ford Whiplash?" General Motors announced at the same time how the Impact would become a vehicle for the mass market. The California Air Resources Board realized this new generation of electric vehicles could solve the state's problem with pollution. The same year, they passed the Zero-Emission Vehicle mandate. It said that if a car manufacturer wanted to sell cars in California, some cars must be free from exhaust. California was a large market, so the car manufacturers didn't have any other choice than to begin selling electric cars.[330]

The Impact evolved into the EV1 [Electric Vehicle 1]. It became the first modern mass produced electric car – 1 117 were manufactured between 1996 and 1999. The EV1 had two seats, a futuristic shape where the rear wheels were almost covered, it was developed in California, and was supposed to be the first in a series of electric vehicles. The next car in the series would be called EV2, the next EV3, and so on. “This is going to represent a great step forward for people in terms of commuting to work, from work, if you don’t have to go more than 120 miles [190 km] a day,” the CEO of General Motors explained when he introduced the car.

Several celebrities enjoyed driving the EV1. The only sound they could hear from the car was a slight hum and the quiet clicks from the brakes. Because there was no lag between pedal and power, the EV1 owner and actor, Mel Gibson, thought he drove the same car as the superhero Batman. “With no gears to complicate acceleration, you get that launched sort of feeling, a childish giddiness called the EV smile,” a driver said.[330]

Another famous EV1 driver was Alexandra Paul, who played a lifeguard in the television series *Baywatch*. “Mine [EV1] was forest green, got 70 miles [113 km] on a charge, and handled like a Porsche,” she said. “A couple years later, improved battery technology in the EV1 allowed me to get 100 miles to a charge and then 120 miles to a charge. It was my only vehicle, and served 95 percent of my driving needs. When I needed to go farther, I borrowed a Toyota Prius.”

Paul had previously owned two other electric cars. She had taken an interest in them ever since the oil tanker *Exxon Valdez* struck a reef in Alaska and 500 000 barrels of oil spilled into the sea. “I was very much on my high horse about it, until I realized that I was part of the reason that the Exxon Valdez was out there in the first place – my car needed gasoline as much as the next person’s to take me from one place to another in my daily life,” she said.[379]

The actor and director, Peter Horton, wanted to join the other celebrities. “I decided to go electric,” he said. “I had seen those sleek, sort of George Jetson EV1s shoot by me with surprising speed on the freeways. I thought, fine, I’ll get an EV1.” But Horton couldn’t find one. General Motors had removed them from the market.[229]

According to General Motors, the EV1 failed. They didn’t believe the car would bring in any profits to the company because the EV1 would never appeal to anyone else than a small group of technology enthusiasts and

environmentalists. But before the car was removed from the streets, 4 000 people had written on a list how they wanted to order the EV1. General Motors called these people and began the conversation with describing the car's limitations. So when they came to the bottom of the list, it had shrunk to 50 people. The private individuals who supported the EV1 wondered if it really was a wise idea to sell a car by describing the limitations. This is how one of the supporters recalled a discussion with General Motors:

"What's wrong with the batteries? The ones in my car seem to work fine," an EV1 owner asked.

"Do you know how much it costs to replace those batteries? A lot," a General Motors representative replied.

"Yeah, but doesn't it cost a lot to replace a transmission or an engine in a traditional car?"

"Not as much as you'd think. An engine's only a couple hundred."

"That's because you mass produce them?"

"Well, that and other factors."

"If you mass produced the batteries, wouldn't their cost come down?"

"Yeah, but we're not."[229]

The final kill to the electric vehicle in California came when General Motors, Chrysler, and several auto dealers sued the California Air Resources Board. In April 2003, California killed the electric car mandate. They thought the batteries were not yet good enough to be a competitive alternative to the gasoline car.

Another technology shift happened at the same time. With one billion dollars, the US Government announced it would support the shift to hydrogen fuel-cell vehicles.[330] Elon Musk is not a fan of fuel-cells and nicknamed them "fool-cells."[328] "If car companies can't figure out anything else to do they give a technology that is always ten years into the future and something people don't quite understand," Elon said. "People say, 'They are doing something for sustainable transport, but we don't understand it and it's ten years away.' And then ten years go by and nothing happens."[366]

General Motors didn't sell the EV1, the customers leased it for $250 to $500 per month. When General Motors canceled the EV1 program, they told the owners they had to turn them in or they would face legal consequences. Some owners wanted to keep their cars, so they fought back. But nothing helped. General Motors called the police who carried away the last supporters

who blocked the truck that transported the last EV1 away from the roads in 2004.[330]

The now heartbroken EV1 owners held a funeral for the cars. You could hear a musical piece with Scottish bagpipes and each owner held a speech. “What the contractors and critics of electric vehicles have been saying for years is true; the electric vehicle is not for everybody. Given the limited range, it can only meet the needs of 90 percent of the population,” an owner said.[330]

A group of EV1 supporters traveled across the country to find out what had happened to their cars. They heard a rumor that the cars had been transported to the General Motors proving ground in Arizona. With a rented helicopter, they flew over the area and found the now crushed cars. “The EV1 had to be forcibly taken from people, and then the cars were sent to some car graveyard where they were squashed, while the customers held a candle-light vigil,” Elon said. “Now, when was the last time you heard of someone holding a candle-light vigil for a product, let alone a General Motors product? How blind do you have to be to not realize that that is something you should be pursuing, not destroying? It’s astounding incompetence. Mind-blowing incompetence. How foolish. Where would GM be today if it had done the EV2 and EV3?”[197]

While General Motors manufactured the EV1, Toyota manufactured 1 480 electric RAV4 EV. 500 of them were still rolling on the roads as late as 2012. One famous RAV4 EV driver was the actor Tom Hanks, famous from the movie *Forrest Gump*. He began to search for an electric vehicle in 2003, and since the EV1 didn’t exist anymore, he had to buy the RAV4 EV. “When the car companies collectively, and, to some, diabolically, decided to take these cars back, the electric vehicles disappeared,” Hanks said. “But not mine. I have the pink slip. I own that car, and it is still driven every day, albeit by one of my crack staff of employees. My electric car recently crossed 50 000 miles [80 000 km] on the odometer with its original battery but without so much as a splash of gasoline.”[191]

In addition to the RAV4 EV, Hanks bought an eBox, which is an electric Toyota Scion xB. The car actually looks like a box and may not win a design price, but Hanks liked it. “There are three electric cars sitting on the Moon, and now another one in my garage,” Hanks said. “The eBox makes even more sense in Los Angeles than in the Taurus-Littrow Valley of the Moon. I can drive all weekend, hauling dogs and helping my friends move, and the

only reason I'll need to stop at a gas station is for beef jerky and lottery tickets."[192] Ironically, it was engineers from General Motors who came up with the best design for the electric Lunar Rover that drove around on the Moon.[348]

AC Propulsion was responsible for converting the Toyota Scion xB to the electric eBox. Alan "Al" Cocconi, thus the AC in the company name, founded the company in 1992. Cocconi had earlier worked with the now crushed EV1. He designed the first prototype in his garage. But as General Motors didn't believe in the EV1, he decided to make a better car on his own.

Cocconi bought a Piontek kit car, converted it to electric power, and renamed it to tzero. "We designed it to show that ultimate performance is available for electric vehicle technology," Cocconi said. The plan was that the tzero would be the first in a series of the next generation environmental friendly vehicles. The name tzero originates from the engineering term t0, which indicates the first measurement of time in a sequence of several measurements, where t1 is the next measurement, and so on.

It was the tzero that convinced Hanks to buy an eBox. "I drove their tzero electric sports car a few years ago, so when they put the same technology in a four-door I wanted one for myself," he said.[219] The yellow tzero wouldn't win a design competition, it had no safety systems, and it was expensive. But it was fast. When the car competed with a famous sports car, the Dodge Viper, the tzero had a better acceleration.[33]

Elon has always liked cars. He has owned, among others, a 2007 Porsche 911 Turbo, a Hamann BMW, an Audi Q7, the 1967 Series 1 E-type "bad girlfriend" Jaguar, and of course the McLaren F1.[4] He used the Porsche as a family car. Two of his children could sit in the tiny back seat.[190] But electricity didn't power any of these cars.

Cars are the type of transportation that consumes the most oil. Out of the 20 million barrels of oil consumed each day in the US, cars are using 25 percent, light trucks are using 18 percent, heavy trucks are using 16 percent, and airplanes are using 6 percent. When there's no more oil to fill the gasoline vehicles, then we have no other choice than to choose another type of fuel. Elon's prophecy is that peak oil will happen in 2020, so he believes a majority of all new cars manufactured in year 2030 will be pure electric. 20 years after that, a majority of all cars on the roads will be pure electric.[360]

“There may be something cooler than a car in 20 years, but the most likely outcome is that we’ll still have cars and they’ll be predominantly electric,” Elon said.[316]

Alternatives such as ethanol or fuel-cells are not good enough compared with the electric alternative. Ethanol may work in countries where there’s plenty of room to grow the plants that will be turned into ethanol, but not in other countries. “Domestic ethanol as the primary solution will definitely not work for the world’s most populous countries, such as Japan, China, India, Pakistan, Indonesia,” Elon said. “Those countries are either breaking even on domestic food production or are net importers. If you argue that ethanol is to be grown elsewhere and shipped, where are the vast tracts of unused arable land?”[248]

Electricity is the best alternative because electricity is like cash – it can be generated in many ways. You can power an electric vehicle by generating electricity from coal, wind, solar, water, oil, natural gas, geothermal, or nuclear power.[359]

Electric vehicles are also energy efficient to use. Let’s say you produce electricity in a coal power plant. If you calculate the CO2 per mile if an electric vehicle is charged with electricity from the coal power plant, the electric vehicle will release less CO2 per mile compared with a hybrid car. This is because even without clean electricity production, it’s very efficient to produce power at a power plant. “What’s important to appreciate is that even if the power is 100 percent coal-generated, the CO2 per mile is still better than a gasoline engine,” Elon said. “The electric motor is incredibly good at turning energy into motion. Mostly what you’re doing with a gasoline engine in a car is generating heat.”[57]

In 2003, Elon went to a lunch in Los Angeles organized by Harold Rosen.[199] With them was also JB Straubel, who first heard of Elon when he attended a Stanford University speech where Elon talked about SpaceX.[214]

At age 14, Jeffrey Brian Straubel, known to all as JB, discovered a discarded electric golf cart. He decided to rebuild it. To find the parts needed, he convinced his mother to drive as far as 50 miles [80 km] in search for batteries, tires, and electric motors. “He was passionate about it,” his mother said. “He wrote to the manufacturers for information. He worked on it every day, all day long, all evening long, until he got it to run. JB was born to be an engineer. He was always passionate about anything that had wheels and required engineering.” To motivate himself, he watch the movie *October Sky*.

“I watch it every year or so,” he said. “It’s inspirational. I always come out of it wanting to work harder.”[213,215]

Straubel has always enjoyed the sound of silence. He can drive for hours without listening to music. This might be the reason to why he became fascinated by machines powered by electricity. “Electric vehicles don’t make much noise,” Straubel said. “When they do, something is not right.” Among other projects, he worked with unmanned electric airplanes, he converted a Porsche 944 to electric drive, and he constructed an electric bicycle nicknamed *the Red Bike*. He was also a fan of the EV1 and you can see him, or his unknown twin, driving it in the documentary *Who killed the electric car?* “I was talking to anyone and everyone to promote the idea that electric vehicles had turned a corner,” Straubel said. “I told them that with new battery technology, they could go much, much farther than anyone thought was possible.”[213,215]

Armed with two engineering degrees from Stanford University, Straubel joined Rosen Motors where he met Harold Rosen who was one of the founders. Rosen had previously worked within the space industry and he’s considered to be the father of the geosynchronous satellite. Straubel and Rosen left Rosen Motors and founded Volacom where they helped the company Scaled Composites – the same company that won the Ansari X Prize.[39]

Straubel and Rosen sat now at the lunch table together with Elon. The topic of the day was space, but they also talked about general topics. Elon mentioned how he came to California to work on a new battery technology for electric vehicles, and how he became interested in them before global warming became a hot topic. Maybe they laughed when Elon said he talked about cars with girls he dated. “And we talked about lithium-ion and what that meant for electric vehicle range.” Elon said. “The EV1 had a range of about 120 miles [190 km] or so with nickel metal hydride and so if you did a direct substitution of lithium-ion for nickel metal hydride, which has directly two times the energy density you get to around a 240-250 mile range, which would be acceptable to people.”[199] It’s true because nearly eighty percent of all Americans drive less than 40 miles [64 km] a day.[59]

They began talking about AC Propulsion. Straubel, who had friends working at AC Propulsion, mentioned that the company developed early prototypes of electric sports cars, and the performance of these cars was

good. After Elon told him he wanted to learn more, Straubel arranged a meeting with AC Propulsion so Elon could drive the tzero.

Despite the car's disadvantages, Elon liked the ideas behind the tzero. He said it was a really awesome vehicle. For several months, Elon tried to convince AC Propulsion to accept funding from him to commercialize the tzero by creating an electric sports car for the mass market. But AC Propulsion was a small company. They wanted to tinker and experiment with their vehicles before they commercialized it, so they declined the offer. AC Propulsion also declined to sell a tzero to Elon and convert his Porsche to electric drive.[199]

What Elon could do was to buy an eBox. While Hanks liked the car, Elon didn't like the idea to convert the Toyota Scion xB. The basic vehicle cost $20 000, the electric conversion cost $45 000, so you had to pay $65 000 for the final vehicle. "Who wants to take an ugly $20 000 car and buy it for $65 000?" Elon asked. "That's not a very viable strategy. I wouldn't want to drive it. My wife certainly wouldn't want to drive it. I said, 'Look, I wouldn't even drive an electric Scion if it was free.' I mean, it's OK as a car, but come on."[4,209]

Elon told AC Propulsion that if they didn't want to manufacture an electric vehicle for the mass market, then he would do it on his own. "Do you want to meet Martin, Marc, and Ian?" AC Propulsion asked Elon.[199]

Martin Eberhard was born in 1960 in California and at age thirteen, he drove his first car. With a degree in computer and electric engineering from the University of Illinois, he had founded several companies.[209]

In 1996, Eberhard co-founded NuvoMedia together with Marc Tarpenning. He was born in 1964 in California and earned a degree in computer science from the University of California. After graduating, he spent the next five years in the oil-rich nation of Saudi Arabia where he worked at Textron - an American company involved in a wide range of products, including electric golf carts.

It was when he was working in Saudi Arabia that Tarpenning discovered the oil industry's darker sides. "The amount of treasure that is sent to the Middle East to supply our oil addiction is astonishing," he said. "And it doesn't necessarily do good things there and it doesn't do good things for us, and that got me thinking that oil is not so great."[453]

In 2000, Eberhard and Tarpenning sold their company to Gemstar for $187 million.[71] Now they wanted to create a new company. “We knew we wanted to solve a real problem,” Tarpenning said. “We just couldn’t do another network widget.” They researched a wide range of major problems, including water scarcity and income inequality. “So we looked at these big problems, and there are a lot of big problems out there, but the one that we took was oil,” Tarpenning said.[453]

The reason why they thought oil was the major problem is because oil causes several other problems, including global warming, political problems, and economical problems. “If you can reduce your dependency on oil everything gets easier,” Tarpenning said.[453]

When US refused to sign the Kyoto Protocol on climate change, Eberhard was embarrassed, and he was concerned about how US had to import oil from troublesome countries. This was when primarily US troops for the second time in twelve years invaded Iraq.[205] “To me, the only way that I can be successful at something is to work at something I actually care about,” Eberhard said. “This time around, the something meaningful I care about was oil consumption. It was clear to me that we had to do something about our oil consumption, both from a global warming perspective and from a national security perspective.”[355]

To calm his nerves, he tried to buy an electric car. But he realized he couldn’t find one to buy. “So I was considering some of the electric cars that were on the market,” Eberhard said. “I didn’t particularly like them, but I thought about maybe I would convince myself to get one. And just about when I had talked myself into that, they disappeared from the market.” He realized not a single car company in America tried to design a decent electric car.[200]

While not petting his Siamese cat, Eberhard cruised around in California. He saw how wealthy people, including actor Clint Eastwood, drove the environmental friendly Toyota Prius only because they cared about the environment. The gasoline price was in 2003 low, so they didn’t drive it to save money.[196] “Every time I get into my Prius, I feel like I’m demonstrating my point of view on national security,” the talent agent, Ari Emanuel, said when he replaced his Ferrari with a Prius.[346]

When the Prius drivers returned home, they also had a Porsche or a similar expensive gasoline car parked in their garage. Eberhard realized a

market existed for a sports car with the same performance as a Porsche and at the same time was more environmental friendly than the Prius – a *Porschius* as he called it.[345] The average income of the EV1 drivers was above $200 000 per year. Since they couldn't drive the EV1 anymore, maybe they would buy a Porschius? Or maybe they needed an electric motorcycle? But the market for such as bike wasn't as interesting as the market for electric cars.[453]

The Prius had both a battery and a gasoline engine, but the battery couldn't charge when the owner parked the car. "Without plug-in capability, a hybrid is just a gasoline powered car with some fancy hardware," Eberhard said. He nicknamed the Prius *dork mobile*. Elon had the same ideas. "You could have the entire country driving the Prius and we'd still be addicted to oil," Elon said. "When you create a hybrid, you're designing an amphibian – and an amphibian is going to be a worse fish than a fish, and a worse mouse than a mouse or whatever creature you want to pick."[197] Elon nicknamed the Prius *gas-guzzling hog*.

Eberhard and Tarpenning examined the electric car market, mainly with the help of a Google search and by ordering brochures on eBay. They came to the same conclusions as Elon had when he did a similar market research. Electric power is the future because electricity gives you the highest efficiency and performance compared with other alternatives.[345] Hydrogen fuel-cells, natural gas, hybrid technologies, and diesel were all dismissed as competitive alternatives.[196] "What surprised me was that electric cars were substantially more efficient than everything else out there," Eberhard said.[205]

The tzero did not only convince Elon, it also convinced Eberhard he could design a true electric sports car. He had earlier invested money in AC Propulsion – they had lost several contracts and were about to go bankrupt – and he also drove the tzero as a daily driver during three months. "The company was about to go out of business," Eberhard said. "When I saw them, they had five employees left and were not paying salaries. I paid their rent and commissioned them to build a car."[223]

The drawback with the tzero wasn't the speed - it was the 60 miles [100 km] range. To increase the range, Eberhard told AC Propulsion to replace the old batteries with thousands of lithium-ion batteries – the same battery as in a laptop or a mobile phone. Eberhard used these batteries at NuvoMedia where he and Tarpenning developed the RocketBook – an early e-book reader

similar to the Kindle and the iPad. Before Amazon developed the Kindle, NuvoMedia negotiated with the CEO of Amazon, Jeff Bezos, if Amazon wanted to invest in their company. But Ebehard didn't agree to Bezos's demands.[411]

The RocketBook's batteries lasted for 20 to 24 hours. When they installed the new batteries, the device became lighter but had the same performance.[344] It turned out AC Propulsion already experimented with the same batteries, and the new batteries worked as expected. The tzero's range increased to 300 miles [480 km] and the acceleration improved to 0-60 mph [0-100 km/h] in 3.6 seconds.[196]

In the summer of 2003, Eberhard co-founded Tesla Motors together with Tarpenning. When they founded the company, they chose between if they should name the company after the scientists Nikola Tesla or Michael Faraday.[350] They agreed on Tesla Motors. Another fan of Tesla is Elon, who even contributed with financial aid to a future Tesla museum. JB Straubel is also a fan of Tesla and one of his favorite biographies is *Wizard: The Life and Times of Nikola Tesla* by Marc J. Seifer.[215]

Born in 1856, Tesla became a productive scientist, and has given name to the units of magnetism, which are units of tesla [T]. At the end of his life, he went a little crazy. He became fascinated by the pigeons in the park and he designed death-rays that would end all wars. "Tesla's problem was that he wasn't entirely sane, and that got worse later in his life," Elon said. "Retaining sanity is important."[128]

In 1943, Tesla died poor and alone in a hotel room. The reason why he was poor was that he could build his inventions in his brain – he almost never made the physical products – so he couldn't make any money. When he finished the design in his head, he became bored, and moved on to the next idea. "I need no models, drawings, or experiments," Tesla said. "I could picture them all as real in my mind. I do not rush into actual work. When I get an idea, I start at once building it up in my imagination. I change the construction, make improvements and operate the device in my mind. It is absolutely immaterial to me whether I run my turbine in thought or test it in my shop."

Tesla and Elon are quite similar to each other. As children, both of them read many books and made experiments. Both studied physics and they moved from other countries to the US. While Tesla decided not to join the

military by living in the forest for a year, Elon moved to Canada to avoid joining the military.

In February 2004, the founding team behind Tesla finished writing a business plan. Their idea was to license the electric powertrain technology from AC Propulsion and to use an existing car manufacturer to build the rest of the car. What they needed now was money, lots of money, so they began looking for outside investors.

One interesting thing they did was to present Tesla in front of investors and friends they from the beginning knew wouldn't invest in the company because they invested in other areas. "We asked them if we could pitch to them this goofy car company idea we had," Tarpenning said. "We wanted the feedback before we shot our silver bullets with the real people that might fund us." Because of the feedback they received, they changed their business plan, including the entire distribution model.[453]

One of their friends they practiced in front of was Ian Wright. He had met Eberhard in 1998 when they sat next to each other on a flight between San Francisco and Tokyo. They began to talk and realized that both were interested in cars and they lived only a short distance from each other. Wright worked as a senior director of engineering at Network Equipment Technologies and was an amateur race car builder and driver.[384]

Wright was also an entrepreneur and he practiced to present his business idea in front of Eberhard and Tarpenning. It turned out that Wright's idea never worked, but he thought Tesla's idea was so interesting that he joined the company. "They were keen to get me to join up because I used to build and race sports cars as a hobby in Australia," Wright said. "I knew a bit more about how cars worked than they did. The tipping point for me was when Martin borrowed the tzero from AC Propulsion, and I got to drive it. That was the thing that persuaded me – although I wouldn't want to buy that car, I could certainly see how you could make something new and interesting with electric drive."[26]

The NASDAQ stock market index was at an all-time low and most investors licked their wounds from the dot.com bubble. They were not interested in financing heavy industry, especially not in companies involved in environmental friendly technology when the price of oil was low. "Back then the only electric vehicles you could buy were golf carts, and the VCs couldn't imagine themselves wanting to buy one of those, so it was a very

uphill battle at that time," Wright said. A few investors were interested, but only if Tesla found a lead investor.[205]

Eberhard had earlier met a person called Elon Musk at a conference arranged by the Mars Society. He contacted Elon by e-mail when AC Propulsion told him Elon was interested in electric cars. Elon replied with an invitation to a meeting at SpaceX.

In April 2004, after a two-hour meeting, Elon decided to invest $6.3 million in the company Tesla Motors.[196] "It's kind of crazy, who in their right mind would start a car company?" Elon asked. "But I guess I have more than my fair share of hubris. I'll do it. I'm in, we'll draw up the paperwork, but we have to close it in three weeks, because my wife is having twins and if we don't get it done by then it's not going to happen."[205] Elon wasn't the only investor, but he contributed with 98 percent of the funding. The other investors consisted of smaller venture capital firms and individuals like Eberhard.[199,209]

But the founders of Tesla and Elon didn't agree on all points. The main difference was that Elon had a larger vision. While he wanted to build a company as large as General Motors, the founders wanted to build a small company. "Well, there are a few things that I disagreed in what they showed," Elon said. "I didn't want to be a niche sports car company. I wanted it to be something that would aim for the mass market as soon as possible."[199] But Tesla didn't have any other options. Tesla needed a deal with Elon far more than Elon needed an investment in Tesla. "You take money from the people who offer it to you," Eberhard said. "People think I'm some kind of rich guy, but I'm not. I still clean the bathrooms in my house, I wash my own laundry, I change my children's nappies."[196,205]

The total number of employees at Tesla was now five. Eberhard became the CEO, Tarpenning became the CFO, Ian Wright became the VP of vehicle development, Elon became the chairman and the head of product design. Straubel joined the company and worked as an engineer for about a year before he became the CTO.[199]

To save the world from its dependency on oil, Tesla needed to manufacture many cars. But that would have been impossible for a newly founded company. A better idea was to begin with an expensive car that might not save the world, but it will start the snowball. Any new technology

on the market is expensive: the first computers, the first mobile phones, and the first gasoline cars. “You can look at the early days of the cell phone – like when you look at the original Wall Street movie where the guy is walking around with the brick phone with a lousy signal and 30 minutes of battery time and it was really expensive,” Elon said. “In those days, if you asked people if eventually everyone would have a portable phone with the power of a supercomputer you would be told ‘no way.’ That’s how it is when you have a new technology – you have to look at where it’s headed. To quote Wayne Gretzky, ‘skate to where the puck’s going to be.’ That’s how it is with electric cars.”[375]

You need two things to make a technology available to the mass market and at the same time make it affordable: economies of scale and optimize the design. Usually at the third version of a product, it starts reaching mass market potential.[322] “Any car that we make at low volume, which is the first version of technology will be expensive,” Elon said. “It didn’t matter what that car look like. We can make something that look like a very standard vehicle, such as a Toyota Corolla, and it would have cost $70 000. But nobody would pay that for what looks like a mid-size economy sedan. But people are willing to pay $100 000 for a fast sports car.”[339]

So the strategy Tesla had was to begin with a high-price, low-volume car. This model’s codename was DarkStar after a classic science fiction movie.[272] You can only charge a high price for a limited number of cars, and you can expect a customer to pay a high price for a sports car. DarkStar would prove that the customers wanted a high-performance electric car. It would also give the company credibility. The suppliers would be willing to write contracts with Tesla and Tesla could find more money from investors who now trusted the company.

WhiteStar would be phase two. That’s a mid-price, mid-volume car. The profits from the DarkStar would pay for the development of the WhiteStar. “In keeping with a fast growing technology company, all free cash flow is plowed back into R&D [Research & Development] to drive down the costs and bring the follow on products to market as fast as possible,” Elon said.[247]

Phase three would be the car with mass market potential. The high-volume, low-price car, with the codename BlueStar. “Our long term plan is to build a wide range of models, including affordable priced family cars,” Elon said.

Tesla thought it would cost $25 million before they could deliver the first DarkStar, but in the end, they would need $140 million. “We hugely underestimated the challenge – the complexity of supply chains, of manufacturing, of the battery design. It was like working through a maze,” Straubel said.[59] “Pretty much everything went wrong,” Elon added. But no one outside of the company knew what was happening because Tesla developed the DarkStar in secret. “Silicon Valley is a great place to run a secret car company,” Eberhard said. “Nobody expected something to sprout up in Northern California, so no one came looking.”[272]

You Can’t Sell a Car That Looks Like Crap

A few years after General Motors crushed the last electric car, an engineer, who had worked with the EV1, made a statement. “Today, with the Panasonic batteries, carpool lanes, free parking at meters, the infrastructure, the subsidies – if we could start over again today with all that, we’d change the world.”[229] Others who noticed an increased interest in electric cars were the Toyota RAV4 EV drivers. Because they got so many questions from people who were interested in how it is to own an electric car, they began to bring with them FAQ fliers.

In the beginning of July 2004, Tesla Motors was just an empty shell. “When we started, we had nothing,” JB Straubel said. “We didn’t have a screwdriver. We had an office.”[209] The office and machine shop were in San Carlos, California. Neither Martin Eberhard, Marc Tarpenning, nor Elon Musk were an automotive engineer. So to learn how to build a car, they did what Elon believed in: read books and learn by doing. Ian Wright, who was an amateur race car builder and driver, and JB Straubel, who had some experience from building electric cars, could teach the others what they knew.[267]

The team might have had little experience, but what Tesla had was the possibility to recruit the right stuff. Designing an electric vehicle in Silicon Valley, not in Detroit, was an advantage. An electric vehicle is like a hybrid between a gasoline vehicle and a computer. “The electric powertrain requires certain kind of engineers that are in the Valley, and the best of them can be found here,” a Tesla employee said. “If Tesla was founded in Detroit, the mindset there is so focused on the internal combustion engine that the level of innovation Tesla was looking for would never have happened.”[335]

The first car from Tesla, the low-volume, high-price model, was the DarkStar. Since it was only a codename, the real name became Roadster. Teslas’s goal with the car was to prove that an electric car didn’t have to be a glorified golf cart. An electric car could look like and have the same, or even better, performance compared with a gasoline car. “We have to make better cars than say GM and Chrysler,” Elon said. “I don’t see that as a huge

challenge. The sad thing in the United States is if people can afford an expensive car, they don't buy an American car."[361]

Tesla designed the Roadster to beat a sports car in a head to head showdown and at the same time be more energy efficient compared with a Toyota Prius.[4] Elon's vision said the Roadster would be the car that inspired other auto companies to design their own electric vehicles. They would ask themselves: if a small company in California can make an electric car – why can't we? "I would like to be able to look back and say: Tesla accelerated the transition from hydrocarbons to sustainable electric transport by at least five to ten years," Elon said. Thus, it's not strange the company's vision became: *Create the most compelling car company of the 21st century by driving the world's transition to electric vehicles*.[382]

As Eberhard and Tarpenning wrote in the business plan, the idea to build the Roadster was to license the powertrain from AC Propulsion and use an existing car manufacturer to build the rest of the car. "Well, so we set out to build a high performance sports car and we looked at who we could partner with to put that car together," Eberhard said.[200]

Tesla decided to collaborate with Lotus. The British sports car manufacturer is well known for its Formula One history with the famous black-gold colored car, as well as the iconic Esprit. But Lotus make at least as much money by selling its engineering expertise. "Lotus was a company that made sense for us because of the size of the cars that they made and the fact that their factory has built cars for other companies already. They're used to doing that," Eberhard said.[200]

To contact Lotus, Tesla went to the 2004 Los Angeles Auto Show where they cornered the Lotus booth. After a convincing speech, Lotus agreed to invite them to England so they could talk to the rest of the company.[200]

The Lotus model Tesla wanted to rebuild was the Elise. Named after Lotus chairman's granddaughter, the Elise happened to be the lightest production car on the road, and light is always a good start for any electric vehicle. In November 2004, Tesla bought an Italian version of the Elise. Lotus had earlier transported the car across the Atlantic Ocean to use it as a demonstration vehicle. But they couldn't sell it to a consumer because of the US legal requirements, so Lotus sold it to Tesla.[355]

Before the original founders met Elon, they made a basic feasibility study to see if the concept really worked. "In the business plan, we had

worked out the basic dynamics of the car well enough to know that the Elise chassis was up to the job, that the weight of the car, combined with the power of a drive system comparable to that of AC Propulsion would give us the speed and acceleration we sought," Eberhard said.[199]

The Elise's exterior needed a new design to make it a genuine Tesla, so they contacted four automotive designers. "We gave all the stylists the same information and they came back with these drawings that were terrible," Tarpenning said. The problem was that no-one at Tesla could speak the design language, so they asked someone who knew design and started all over again with a new specification sheet. "It had these pictures of cars and little sliders and it would say 'feminine' and you would slide the little thing over," Tarpenning said. "It was in design language." Apparently, it worked because when the new design suggestions came back they were right on.[453]

At a Christmas party in December 2004, Eberhard taped the proposed design suggestions to a wall and asked Tesla's first employees to choose their favorite and least favorite aspects of each design. The best design was the sketch by Barney Hatt, who worked as a designer at the Lotus Design Studio. His design was different enough that Tesla could call it their own car.[209]

The process of building the Roadster began. Tesla opened an office at the Lotus campus Hethel in Norfolk, England, which is built on an old airfield previously used by American bombers during the Second World War. They also hired several engineers who had been forced to leave Lotus because of financial reasons. The Roadster is not built on an Elise chassis – Tesla licensed the Elise chassis technology and the engineers in Britain designed the Roadster's chassis using that technology.[267]

As Elon had no direct responsibility in the design process, he attended the Tesla board meetings once every six weeks, and he phoned every couple of days. They often used his private jet. "He lives in southern California, but he'd jump in his jet and fly up here at a moment's notice," Tarpenning said. "When we were trying to recruit some pretty high-level people from Detroit, Elon flew his jet here, picked us up and took us along to meet those people." Also Eberhard was impressed by Elon's lifestyle. "It was surreal. I'd go to visit him in my Mazda 3, and we'd go for a drive in his McLaren F1," he said.[205]

Elon let Eberhard run Tesla without interfering in the daily work. Using skills gained from building rockets at SpaceX, Elon could often suggest new types of materials and techniques to use in the Roadster to save weight. He

also worked with building the Tesla brand. “There were signs that he wanted to fiddle in the details, but it wasn’t enough to make me run screaming,” Wright said. “Musk is a technically savvy guy who wanted to help.” Elon, who had owned several of the world’s top sports cars, was particularly interested in the Roadster’s body styling. “You will see elements of two of my favorite cars, Porsche and McLaren F1, in the Roadster body,” he said.[421]

Nevertheless, by dint of his personality and controlling instincts, everyone noticed how Elon became more and more involved in the design process. Eberhard wasn’t the only manager the engineers had to ask if they wanted to make a change. “What will Elon think of that?” everyone asked themselves.[196]

Eberhard realized he and Elon had different priorities. While Eberhard wanted to finish the Roadster as soon as possible by using standardized parts, Elon wanted to redesign the standardized parts. “Elon wasn’t involved in the day-to-day management of the company,” Eberhard said. “His hands-on involvement was mostly pot shots. He would come in and get worked up about one particular thing on the car. He would get all fired up about door latches without contemplating their importance compared to the more difficult problems we had to solve. He would become obsessed. He couldn’t have a conversation without it being about the door latch.”[205]

The development of the Roadster turned into a tug-of-war between priorities. To design the logo, the look, and the feeling of the car, Eberhard wanted to spend $30 000 on a focus group. Elon canceled the project. To market the new Roadster, Eberhard hired a PR firm. Elon fired the PR firm because he thought his involvement in Tesla would give the company enough publicity. Elon let his wife test the car, and when she had trouble to get out of the car, it had to be redesigned. “Have you tried getting out of an Elise? It’s like you have to be a contortionist,” Elon said. After riding for a weekend in an early prototype, Elon insisted the seats had to become wider in the hip area and have more padding. To make the Roadster look, feel, and smell more like a sports car, the dashboard needed more leather. Elon wanted the door handles replaced with touch-sensitive microswitches at a cost of $1 million. The Roadster needed new lights. “My opinion was that if we had uncovered headlights it would look like a kit car – a little cheesy,” Elon said.[196,205]

To solve all these problems, Tesla needed to find new suppliers because Lotus hadn’t signed on to make new parts. “We learned that the car industry is unbelievably good at delivering what they’ve done in the past with a little

tweak – faster, or in yellow," Tarpenning said. "But if you want something a lot different – a simplified transmission that's electrically actuated – that's too radical. The designers and engineers who can do radical changes all left Detroit forty years ago."[59]

When Tesla added everything needed to make a production car, including stereo and safety systems, the Roadster became heavier than the tzero and thus slower. "Why did DeLorean fail?" Elon asked. "Because it was a shitty sports car. It may have looked cool, but it had the acceleration of a Honda Civic."[196]

Elon demanded a top speed of at least 125 mph [200 km/h]. Eberhard, on the other hand, was satisfied with a top speed of 110 mph [180 km/h]. "I thought it was an unnecessary risk for the first model year's cars," Eberhard said. "I was not proposing performance that sucked. We thought that we might just break 4 seconds [0-60 mph, 0-100 km/h] with Tesla's additional weight, with our worst case estimates coming in around 4.8 seconds. This is still extremely quick for a sports car, and would have been a great car."[199]

To increase the performance, the Roadster needed either an improved motor and electronics or a two-speed transmission. Tesla didn't have the competence to rebuild the technology from AC Propulsion, so to get this improved performance, the Roadster needed a two-speed transmission. While the Elise used a transmission from Toyota, Tesla couldn't find an existing transmission because an electric car is different from one powered by gasoline.[199]

Tesla hired a company to design this new transmission, but it didn't work, so they changed to another company. The Roadster had been delayed by now, so this decision was rushed, and they chose this company because an engineer at Tesla in England had a contact there. It turned out that nor this transmission worked, so Tesla contacted a third company. Although they could build the transmission, it would be expensive. "Wow, so the huge development cost with a nominal timeline of like November 2008 and a high unit cost," Elon said. "That's pretty shitty."[199]

Elon and Straubel had now become tired of the two-speed transmission and began discussing the original idea. "Hey, look, why don't we look to going back to the single-speed approach and upgrading the motor power, and the power electronics current capability?" Elon asked. "We'd be better off with a single speed vehicle where we put more focus on increased torque and

power out of the motor, rather than relying on this old-world solution of complicated gearboxes and moving mechanical parts."[199]

To make sure they got a working transmission they contacted two companies. If both designs worked well, they would pick the lower cost option[199,213] In September 2008, Tesla chose the company BorgWarner to manufacture a single-speed transmission.

Coloring was easier when Henry Ford made cars. He told his customers they could choose whatever color they wanted as long as they chose black. Why black? Black was the color that dried the fastest. But the Roadster came in twelve colors and each color needed a special name. "Oh boy, the naming took some time," a Tesla employee said. "After several PR and design people took a run at it, we held a competition amongst the employees. We were running out of time. Three Tesla Motors executives were dragged into a conference room and were not allowed out until each color had an agreed upon name." So the Roadster got colors like Electric Blue or Sterling Silver. It turned out that Radiant Red was the most popular color among the customers.[270]

The Roadster became more and more expensive and it took longer and longer to get it into production. "I always argued that we would sell exactly as many cars whether the door latches were push-button or electronic, whether the body panels were carbon fiber or fiberglass. All the nicer, cooler, faster stuff increased risk," Eberhard said. But Elon disagreed. "I was very insistent on things during the design phase, and it is true those things cost money, but you can't sell a $100 000 car that looks like crap," Elon said. "On some of these changes I had to be quite forceful because Martin [Eberhard] didn't want to spend the money."[196,209]

Because of all these changes, the Roadster and the Elise became two different cars. In hindsight, it would have been a better idea not to redesign the Elise. "We have the same airbag system," Eberhard said. "We have a similar crash protection system. But it isn't so much based on the Elise. There was maybe ten percent common parts to it in our cars. The windscreen, the airbag system, some of the surround, some of the rubber seals, that kind of thing. The chassis of the car is not a Lotus chassis and the body is clearly different than the Lotus body."[200]

Another part that differed from the Elise was the engine. Tesla decided to use a modern version of an engine developed by Nikola Tesla himself. With a diameter of 25 cm, the 250 hp engine would sit on the rear-axis. It weighed only 60 pounds [27 kg], which is considerable less compared with a regular gasoline engine.

The batteries needed to power the engine in a Tesla car are the same batteries as can be found in a laptop: lithium-ion batteries. These are the best batteries available for purchase and for installation in a car, and they will probably be so for a long time. “We looked at some of the other chemistries of batteries around and they’re either not available actually, you couldn’t actually buy some, which is a drawback to putting them in a car, or they have substantially lower energy density,” Eberhard said. “Energy density translates to shorter driving range, and for us driving range is one of the most important factors for an electric car to be successful.”[200] This was one of the topics Elon and Eberhard didn’t disagree on. “Lithium-ion batteries are the most efficient way to store electricity today, but I suspect we will find that there are even better technologies down the road,” Elon said.[248]

The final battery consisted of 6 831 smaller cells. There are six to twelve of these cells in a common laptop battery. Compared with a regular lead-acid car battery, these batteries are lighter and more powerful, and they don’t contain any hazardous material. You can recycle a laptop battery in a similar way as a soda can, and Tesla joined a recycling company that will take care of used batteries. “I wouldn’t recommend them as a dessert topping, but the Tesla Motors lithium-ion cells are not classified as hazardous and are landfill safe,” Elon said. “However, dumping them in the trash would be throwing money away, since the battery pack can be sold to recycling companies.”[247]

Everyone who has used a laptop knows that the performance of the battery will decrease as time goes by. But you can’t compare a laptop battery with the battery in an electric car. The difference between the Roadster and a laptop is that the laptop wasn’t designed to last several years. A laptop’s hardware will be obsolete after a few years, so why would the battery need to last longer? “I mean, Microsoft just conspired to make sure that your laptop is obsolete in five years and so if the battery pack poops out in five years that’s okay, that’s fine,” Eberhard said.[200]

In a car it’s possible to optimize the battery’s life-length. One of the aspects affecting a battery’s life-length is the temperature around the battery.

While the battery in a laptop is exposed to heat from the rest of the computer, the battery in a car will be cooled to an optimal temperature.[200]

Another aspect affecting the life-length of a battery is how you charge it. The optimal way is not to charge the battery to 100 percent, as is often done with a laptop battery because the cord is always plugged in. To improve the life-length, Tesla developed algorithms to optimize the charging and discharging of the battery.[200]

The risk of a failure in one of these batteries is low. Sony has made about eight billion lithium-ion cells so far, and only eight of those have caught fire.[355] "You have them in smartphones and no one is worried about having those near sensitive parts," Elon said. "It is also why arsonists tend to favor gasoline. Trying to set the side of a building on fire with a battery pack is far less effective."

To be on the safe side, a Tesla battery consists of several cells. Tesla catastrophe tested the battery by heating individual cells until they burst into flames. If one cell overheats, it will not start a chain reaction explosion. Several sensors detects acceleration, deceleration, tilt, temperature, and smoke. If one sensor detects an abnormal event, like if the Roadster is involved in an accident, it immediately shuts down and disconnects the power system. "We had to think about all different types of crash scenarios," Straubel said. "So there's really a lot of what-if type of engineering."[347]

So to avoid peak oil, we just need to replace our gasoline vehicles with vehicles powered by lithium-ion batteries. But isn't there a peak lithium like there's a peak oil? It's true that the supply of lithium is not endless, but if the price of lithium increases, then it will be profitable to extract lithium from sea water. According to research, there are 230 billion tonnes of lithium available in the sea. "There's a lot of lithium in the world," Straubel said. "Lithium gets talked about as the resource constraint in many cases, but there's surprisingly small amounts of lithium in a lithium-ion battery. We are more concerned about nickel and cobalt."[426]

A battery pack in a Roadster will last for 100 000 miles [161 000 km] or seven years. After this time or distance, Tesla expects the battery pack will retain approximately 65 percent of its ability to hold the initial charge.[382] It's currently expensive to replace the batteries, but Tesla believes the price of the new batteries will decrease due to technological progress. "Technology in these batteries is constantly improving," Straubel said. "It's a pretty exciting thing from a car point of view. Lithium-ion batteries are getting better by

maybe seven or eight percent every year. A little bit more energy and range, and also the cost is improving. So, it's a very exciting time." Electric vehicles ten years from now may thus have twice the range of today, or a battery pack that weighs half as much as the battery packs weighs today.[234]

In the end, the Roadster got a range of 244 miles [393 km] per charge. But a customer claimed he had driven 347 miles [558 km] before his Roadster needed to charge.[360]

The Roadster became more and more expensive, so Tesla needed more investors. In 2005, Elon invested more of his own money, and he convinced the Google founders, Sergey Brin and Larry Page, to invest some of their money.[196]

The film crew behind the documentary *Revenge of the electric car* wanted to film a Roadster. Straubel delivered it to the movie set. The prototype car had a gaping hole where the front grill should have been. To hide the flaw, the film crew took a quick trip down to Home Depot for some landscaping mesh and they went to Office Depot for some metal binder clips. Now they could fabricate a grill so no one could see that the Roadster wasn't finished. Straubel was impressed and the film crew told him he could keep the design.[212] "I thought my portrayal in the film was OK," Elon said. "There were moments that made me want to cringe, that were terrible, but over all I'm not unhappy to be in the movie."[432]

In January 2007, the now 205 employee strong company wanted to test if the Roadster could survive harsh winter conditions. They traveled to Arvidsjaur in the northern parts of Sweden, 68 miles [110 km] south of the Arctic Circle. During the winter, the Sun is above the horizon for only four hours each day.[246] The area is favored by car manufacturers from around the world for cold weather testing. Not only cars must be able to survive a cold climate, military personnel from across the globe travel to this region to learn how to endure extreme winter conditions. "It was minus 55 degrees Celsius [minus 67 degrees Fahrenheit]," the British survival expert, Ray Mears, said when he was in the area. "At that temperature you cannot make a single mistake – if you make a mistake you're going to end up with frostbite. So you have to be very, very careful."[23] The ironic part of testing an electric vehicle in Arvidsjaur is that the area has become warmer, most likely due to

global warming, so several car manufacturers have moved on to colder proving grounds in China.

A harsh winter climate is a problem if you are driving an electric vehicle. When the temperate drops to minus ten degrees Celsius [minus fourteen degrees Fahrenheit], the range of a Tesla will decrease by ten percent. This is primarily due cabin heating that requires more energy the colder it is. “The battery actually loses very little energy when cold,” Elon said. “Keeping batteries cold is actually the best way to preserve them. It only loses energy when keeping the pack warm for the convenience of the driver – so you don’t have to wait long to drive.”[224]

Other tests the Roadster had to endure included the Belgian Pavé test, where the car was driven over a harsh cobblestone road at high speed. Almost any car will break after 4 000 [6 400 km] to 5 000 miles. “We finished that test and actually did quite well on it, had a very small number of failures. We had one bracket break on a front suspension component that we redesigned,” Eberhard said.[200] During these types of tests, and because of the constant vibrations, you can only drive for 30 minutes before you need a break. One poor Tesla driver thought the Roadster would fly apart and his teeth would shake loose.[453]

There’s also a much longer durability test - about 50 000 miles [80 000 km] long. While driving on that track, one misery the car has to endure is a saltwater bath. “We did have some water getting into one of our cables,” Eberhard said. “So it required us to change the design of the cable and make sure it was simply more waterproof.”[200]

The German company Siemens manufactured the Roadster’s airbags. But Siemens became nervous because they didn’t know if Tesla knew how they would use their airbags. The only way to calm them down was to let Siemens do the crash tests themselves. Four hand built Roadster were transported to Germany and systematically destroyed.[209]

In July 2006, the first Roadster prototype was finally revealed. Celebrities like the movie star and politician Arnold Schwarzenegger attended the uncovering show at the Santa Monica Airport. Later the same year, Tesla showed the Roadster at the Los Angeles Auto Show where Schwarzenegger held a speech. “Every industry has to participate in the fight against global warming, and these clean, efficient alternative fuel vehicles are leading this environmental revolution,” he said. “I test drove this vehicle [the

Roadster], and it is hot. I'm buying one for Maria [his wife], for her birthday."[336,355]

Tesla's Macintosh

You can compare the Roadster with Apple's first computer, the Apple I. Elon's vision was that the next car from Tesla would be comparable to Apple's Macintosh.[195] As with the DarkStar, the WhiteStar was also a codename, and the real name of the mid-price, mid-volume car, was Model S.

Perhaps the most important lesson learned from designing the Roadster was that it's more efficient to not redesign someone else's car. "The biggest single error we made with the Roadster was not starting from scratch," Elon said. "It would have cost us less and resulted in a better car if we had started with a clean sheet. So it was like you wanted to build a house, couldn't find the right house, so you try to fix an existing house and end up changing everything except for one wall in the basement."[190,235]

Tesla hired Henrik Fisker to design Model S from a clean sheet. The Dane, who had designed the latest Aston Martin, had now a styling company called Fisker Coachbuild that conceived unique bodies for existing chassis.

When Fisker showed his design suggestions, Tesla thought they were horrible. And they thought they knew why. Fisker would soon work with a competing car at Fisker Automotive. Tesla suspected that the only reason why Fisker had accepted the job was that he wanted to get an insight in how the engineers at Tesla worked. A sort of industrial espionage.[327] "The initial proposals he came with were pretty good, and then as we got into it they started getting worse and worse," Elon said. "I was very puzzled as to why he was producing such awful designs for us. The design Fisker did for us was nicknamed 'the white whale' it was so bad. It turns out what he actually decided to do was to take our specifications for the Model S. He took that basic plans, shopped it, got it funded, didn't tell us."[190,374]

They sued each other, and the court ruled in favor of Fisker. "There is no reason I would design a car purposefully bad," Fisker said. "That's just ridiculous." It's common that the best car designers work with different auto manufacturers, and Tesla knew Fisker had founded his own car company. Fisker thought Elon needed to blame others for his own difficulties. "On a

trivial level, it reminded me of the O.J. trial," Elon replied to the court's decision.[374]

To avoid a similar experience, Tesla created their own design studio in a small, white tent carved out of a corner in the back of the SpaceX factory. Now they needed a designer.

Despite the German-sounding name, Franz von Holzhausen was born in 1968 in Simsbury, Connecticut. After graduating from the Art Center College of Design, he worked for various car companies. He spent eight years at Volkswagen and Audi where he learned the German way to combine design with quality. Then he brought his knowledge to General Motors where he worked with the cars Pontiac Solstice and Saturn Sky. After leaving General Motors, the next challenge was working with Mazda's Kabura concept. "So what I learned from all these positions was how to develop a brand," von Holzhausen said. "I learned discipline from the Germans while in America - it is about the free spirit, the message is what a brand can do. Sometimes, when I'm driving on the freeway, I see people in cars that I've designed or helped design. I look closely, because I want to see what kinds of people are driving those cars."[239,241]

A friend of a friend called von Holzhausen and told him he should consider working for Tesla. Von Holzhausen had earlier read about Tesla and he thought their solution was too complicated. But it turned out von Holzhausen planned to leave his current job because he had become sick of Mazda's priorities. "We had just come off a car that was all about being green in the racing environment," he said. "We had done a lot of work with sustainable materials. We were the only ones to have non-vinyl interiors in the industry, but the company was not really embracing it."[240]

Because von Holzhausen wasn't happy at Mazda, he decided to meet Elon. "I came up to Tesla and did a tour of the facilities and we talked about opportunities," he said. "Here was a company that was putting all its marbles behind what it believed in. Until that time I had worked for companies that talked a good line, but their core values were in a different direction." Elon gave von Holzhausen an offer he couldn't refuse. If he joined Tesla, Elon would give him the opportunity to design a new car from a clean sheet. It's a dream job for all designers, so von Holzhausen accepted the offer and became Tesla's chief designer.[240]

Elon told von Holzhausen he wanted a four-door sedan that seated seven together with their luggage. "That's an SUV, not a sedan," von Holzhausen

replied.[210] Elon told him he wanted to redefine the sedan concept and he also needed a car with a capacity to carry himself, his wife, and his five children. So von Holzhausen set out on the mission to design Model S together with a team of designers. “We immediately began building the design team, which eventually grew to eleven people,” von Holzhausen said. “We worked grueling hours, fueled by countless take-out dinners, lunches and breakfasts, not to mention ample caffeine and snacks in the SpaceX cafeteria.”[274]

Before Eberhard co-founded Tesla, he wondered why no one could build an electric car with the same performance and design as one powered by gasoline. “When I looked at so many electric cars out there, it seemed to be that they were built by people who considering driving a necessary evil,” Eberhard said. “You really shouldn’t drive. You should walk or take a bike or ride the bus. And if you must drive then a little glorified golf cart would be fine.”[200]

Nor von Holzhausen understood why an electric car couldn’t look like a gasoline car. “What we set out to do for the Model S was to be the cornerstone of the brand, to identify the building blocks,” von Holzhausen said. “The Model S does not look like a science project, you will be comfortable parking it next to a brand with 100 years of experience.”[239]

To design Model S, Tesla interacted with the early customers, they spent a lot of time at the stores, and they developed a short feedback loop. Concerns, ideas, and issues were constantly evaluated. “The hardest thing to do with a blue-sky project like this is to contain yourself. It is easy to overshoot,” von Holzhausen said. “The Karma [Fisker Automotive’s car] is a great example of that.”[239]

Designing an electric car is different compared with designing a gasoline car. The advantage with the car powered by electricity is that the designer has much more space to work with. In the Model S, von Holzhausen realized almost everything above the wheels would be free to mold. The small electric motor didn’t use much space, and the batteries formed the bottom of the car. Because of all free space, von Holzhausen could live up to Elon’s demands. Seven people could sit in the car, including two small children in the trunk. With seven people in the car, it’s still possible to have luggage in the front trunk, or the “frunk” as Tesla calls the front trunk.[51]

Another aspect the designer of an electric car has to consider is to optimize the design to lower the wind noise. The wind noise in a gasoline car is not audible because of the noise from the engine, but an electric car is

silent. Some drivers are not used to the silence, so engineers have suggested adding a fake gasoline engine sound. “Some people are going to miss the sound of a roaring engine, just like people used to miss the sound of horse hooves clippity-clopping down the street,” Eberhard said.[272] But some drivers enjoy the silence. “I opened the sun roof, rolled down the windows, and I pulled out,” one electric car driver said. “It was like a magic carpet. You hear people laughing, talking, and you’re interacting with the city.”[381]

As when Tesla designed the Roadster, Elon could suggest materials and techniques from SpaceX to improve Model S. “In the rocket business, we are used to dealing with very light weight materials, so a lot of advanced aluminum, advanced joining techniques, new types of welding and bonding and that kind of thing,” Elon said. “We employed that also in the Model S. The body and chassis is all in aluminum, which is rare. Most cars is steel and maybe a little bit of aluminum.”[449]

Elon and Steve Jobs share the same eye for design. Once, Elon brought in several competing cars so they could compare them with the Roadster and the Model S. Because of the comparison, you could hear the following comments from Elon:

”…the screws on the hinges feel like knives stabbing me in the eye.”

”…find the best visor in the world, and then make a better one.”

”…that’s like a midget cave. It’s good to get a sense for just how bad the other cars are.”[51]

But Elon has been described as nicer than Jobs and a bit more refined than Bill Gates.[51] Elon actually tried to talk to Jobs when they attended the same party. Larry Page, who lived three blocks away from Jobs, introduced Elon to Jobs. But Jobs was super-rude to Elon. Despite the rudeness, Elon is still a fan. “He was an incredible guy and made fantastic products, and there was a certain magic about him that was really inspiring,” he said. “I think Steve Jobs is way cooler than I am.”[363]

The original plan was that Model S wouldn’t be a true electric car. “We were looking closely at doing a plug-in hybrid at Tesla and for a brief period the Model S was gonna be a plug-in hybrid,” Elon said. “But as we drew deeper and deeper into the design, we concluded that we could not make a compelling hybrid. We just didn’t like what we came up with. The market will decide whether we were right or wrong.”[435]

Due to the electric engine and the material, the Model S got a better acceleration compared with a sports car. A favorite prank at Tesla is to invite a prospective customer and ask the unsuspecting passenger to turn on the radio. At the precise moment as the passenger leans forward towards the control panel, they accelerate. Because of the fast acceleration, the passenger can't lean forward enough to reach the radio.

Model S got a large touch-screen between the driver and the front passenger seat. The 17" screen looks like an iPad. "It is a leap forward, you need no knobs," von Holzhausen said. "Before we launched we were a little unsure if some would miss the old world. Customers love the screen; it's amazing how fast they become totally comfortable with it."[239]

But even the best designer makes mistakes. The Tesla team decided not to install reading-lights in the backseat. They didn't think people would read traditional books - they thought people would read on e-book readers that doesn't need an external light source. Once, when Elon drove his Model S with his kids in the backseat, one of them decided to read a book. But he couldn't find a light, so he said, "This is the stupidest car in the world." Elon, who always seek out negative feedback, decided to install reading-lights in the backseat.[419]

Building a car is similar to building computer software. "There are a couple of key milestones," Elon said. "You've got the alpha phase, the beta phase, the release candidate, and then finally you are in production. The beta vehicles will be almost indistinguishable from the final production designs."[441] In March 2009, Tesla completed the Model S prototype (the alpha phase) an unveiled it in front of hundreds of people in the SpaceX factory. A proud von Holzhausen pulled the silver sheet off the car, and it sparkled under the white spotlights. "You'll see that this isn't some show car that doesn't do what it says it'll do. It'll go fast with a lot of people in it," Elon told the crowd.

But everyone weren't convinced. "I wouldn't call it Tesla Motors yet," a critic said. "I would call it the Tesla prototype company. My concern is that there are people in charge who don't have a realistic view of the car industry." The same critic thought the Model S would never see daylight. Tesla would need 30 to 40 years to become a profitable company, and $700 million to successfully develop and mass produce Model S. "I will eat my hat if we spend anything close to $700 million on our model-2 car [Model S]," Elon replied.[372]

Neither Tesla's customers were enthusiastic when photographs of a Model S beta leaked on the Internet. Tesla had tested the car on the streets in Palo Alto and someone took photographs of it. "Wow, I hope that wasn't a Tesla design bound for production, or I'm pulling my reservation," one said. "That thing was not what they have been selling on their website. The proportions were, in a polite term, boring." Another customer said, "There is no way Tesla is going to get most people to pay $50 000 or $60 000 for the car in this photo. It looks like a Ford Probe from the late 80's."[442]

Trouble in Paradise

Elon Musk married Justine Wilson in January 2000. The life of Elon and Justine, or simply J as he often called her, looked like something out of a dream. “The happiest moments of my marriage took place in the earlier years, on the Saturday and Sunday mornings when Elon and I went to the bookstore, then took our purchases to a cafe and read over coffee and just hung out,” Justine said.[133]

They lived in a small apartment together with three roommates and two dogs. The Musk family would later include more dogs, and a chicken the family adopted when a petting zoo left it behind in a park.

Justine’s sister thought Hobbes, the Yorkie, had a mental problem. Together with other dogs, he turned manic and yappy. But the loud barking stopped when Hobbes became really sick and was admitted to the animal hospital. “I’m very sad. I mean, I know you don’t like him very much,” Justine told Elon. “Well, I certainly don’t want him to die or anything,” Elon replied. “Poor Hobbes.”

The old debate champion Elon can convince most men and women. Those who will interview Elon are often warned, “Don’t bring any cash, because you’ll be offering to give it to him twenty minutes into the interview.”[195] Elon even convinced a friend that Hobbes was not a Yorkie, but a South Seas Terrier. He argued their long coats protected them against the chill of the ocean as they swam from island to island.

Hamlet was the gentle giant Great Dane. His name originates from *The Tragedy of Hamlet, Prince of Denmark* by William Shakespeare. Elon and Justine thought their dog was another great Dane. To help them walking Hamlet, they hired a dog walking agency. The agency told their brave walkers how to handle Hamlet:

> “Great Dane, male, black and white, 2 years old, very sweet with people… HAMLET HATES OTHER DOGS. KEEP HIM AWAY AT ALL TIMES. HE WILL ONLY PULL IF HE THINKS HE CAN GET TO A DOG. HAVE A GOOD GRIP ON THAT LEASH. Hamlet may

try to hold your arm in his mouth during the walk, or he may put his mouth around your ankle when he thinks you're ready to leave. This is just him being affectionate. The more he knows you, the more he will become very attached to you. Do not wear open toed shoes. Hamlet has a foot fetish!"

Bowie was the Miniature Dachshund who had a higher rank than the much larger Hamlet. One of her favorite occupations was to rest in Hamlet's giant dog crate. The Great Dane couldn't fit in Bowie's dog crate, so he had to lie on the floor.

Leroy was son of a Miniature Dachshund and a Yorkie, probably Hobbes and Bowie. The Musk family found inspiration from the song *Bad, Bad Leroy Brown* by Jim Croce when they came up with his name. Leroy was a good escape artist because he had no fear. Although they tried to seal the walls of their garden, the dog escaped by jumping off the steep cliffs that surrounded their house. Hours could pass before he showed up at their front door as if nothing happened. "The dog has the biggest ego I've ever met in any dog," a dog trainer said. "You're lucky he's not any bigger than he is, or you'd have a real problem."[163,164,166,168,174]

As Elon sold more and more of his companies, the couple moved to larger and larger houses – or rather mansions. To get a feeling of the neighborhood they lived in, there's a story about when a rich neighbor came over to their house. There were three parked cars on the driveway that night: a Ferrari, a Mercedes sedan, and a Cadillac Esplanade. "Wow. Look at that car. What a beauty. Can I get in it?" the rich neighbor asked. Everyone thought he would go to the Ferrari, but he went over to the Mercedes. He opened the back door and sat down in the seat. "Wow. This is great. What a beautiful car," he said. Everyone realized the rich neighbor didn't have a driver's license. He had been chauffeured around his entire life, so why would he need to test the driver's seat?[173]

The couple visited black-tie fundraisers and got the best tables in the best Hollywood nightclubs. Villa, owned by the actors Mark Wahlberg and Leonardo DiCaprio, was so exclusive almost no one in Los Angeles knew of its existence. Outside of the club, there was a crowd of gold diggers trying to get in and paparazzi photographers trying to get the latest gossip pictures. But Elon and Justine could sneak by them.[151]

They visited the exclusive Hyde Lounge at the Sunset Boulevard,

famous for being the place where Britney Spears stepped out of a car without any panties. Elon and Justine arrived to the club together with their famous neighbor. They were used to the paparazzi photographers, but they were also used to being ignored by them. Elon and Justine were no stars the public wanted to read about in a gossip magazine. This time, however, because they arrived to the club together with their famous neighbor, the photographers ran to their car to take pictures.[156]

They were invited to a New Year's Eve party at the same house as where Marsellus Wallace lived in the popular movie *Pulp Fiction*. When Marsellus Wallace moved out after the movie had finished, a lawyer moved in. At law school, this lawyer skipped the lectures to watch at least two movies a day. He thought law school is the fallback position for smart kids who don't know what to do with their lives. After school, he made money from the dot.com bubble and could now live in the famous house.[177]

Elon and Justine traveled to Richard Branson's private island in the Caribbean, the Necker Island, to attend the marriage of the Google co-founder Larry Page. They used their private jet, a Dassault Falcon 900, to visit similar remote locations. "Town car picks us up, drives us to small private airport, up to private jet, where personal flight attendant greets us at the door and someone else deals with the luggage," Justine said. "All I had to do was request a glass of champagne, which was then magically deposited into my hand."[146]

Both Branson and Page enjoys kitesurfing, which is an extreme sport that combines windsurfing, gymnastics, and paragliding. Kitesurfing has become popular among technology enthusiasts and Elon has joined the crowd. "I'm a terrible kitesurfer," Elon said. "At some point I would like to be less terrible. It's kind of a fun thing. It definitely appeals a lot to the high-tech crowd because it's sort of a high-tech sport. The kite-technology is constantly evolving, it's an interesting challenge to manage the kite while you're surfing across the waves, it's a good adrenaline rush. Yeah, it's fun. It's like the most fun thing you can do if you have some spare time."[441]

The name of Elon and Justine's first child was Nevada Alexander. When the boy was ten weeks old, they put him to bed on his back for a nap. But he stopped breathing. This was at the age when male infants are most susceptible to sudden infant death syndrome. The paramedics arrived and they resuscitated him. It was too late. The boy had been out of oxygen for so long that he was brain dead.[182]

In 2004, the twins Griffin and Xavier were born, and in 2006, the triplets Kai, Damian, and Saxon were born. The children inherited the genius-boy-genes and at least one of them scored in the top percentile when he did an IQ test. He had neither the same problems with bullying in school as his parents had. “Even the older boys like to play with him,” his teacher said.[135]

Before the children went to bed, they enjoyed listening to their mother’s made up Darth Vader stories. Vader is the bad guy in the *Star Wars* movies. “Bad guys and monsters are my favewits,” one of them said. Sometimes they liked a Chewbacca story, who may look like a monster, but is a really good guy. Justine knew what she told them – she was obsessed with the first *Star Wars* trilogy in high school. Her dream was to be an Angelina Jolie if she learned how to use the Force.[148,152,176]

As the children grew older, Elon took them to Disneyland. “I’ve been to Disneyland like ten times. I’m getting really tired of Disneyland,” he said.[53] Together with his former roommate Adeo Ressi, both families have begun with Daddy Camping, which is camping trips with their children to the Yosemite National Park.[117] Elon is also building model rockets and play video games with his kids.[127]

Elon, who earned a bachelor’s degree in physics and economics with an unofficial minor in first-person shooter games, continued playing games. When Elon and his friends were deep inside a game, Justine realized she had to feed them. “Because you have the feeling that your husband and friend would gnaw their own flesh rather than break from their playing to scrounge for something so silly as food,” Justine said.[149] Elon’s favorite games included *BioShock* and *Fallout* – both games unfolds in a dark future. Maybe the same future Elon is saving us from?

Justine was worried. “My fear is that we become spoiled brats, that we lose a sense of appreciation and perspective,” she said when Elon bought the McLaren F1.[27]

Several years later, the relationship began to crumble. “Elon’s central relationship is with his work. I like to compare him to the Terminator. He sets his program and just… will… not… stop,” Justine said.[59] When Elon and Justine were going somewhere in the evening, they arrived individually. Elon came nearly always directly from the office. “He’s not some rich guy sitting

by a pool somewhere. When I go home at eight o'clock at night, his car is still in the lot," an employee said.[4]

"I came to the United States because this was the one place where all of this was possible – to make your fortune, but to also realize dreams," Elon said. "On the other hand, you can't just dream, you have to work hard at it."[60] A high intrinsic drive is the factor that made it possible for Elon to reach the point he has in life. "I can get really set on something, and then I just keep going in that direction," he said. "If other people are putting in 40-hour workweeks, and you're putting in 100-hour workweeks, then, even if you're doing the same thing, you will achieve in four months what it takes them a year to achieve."[326,409] His brother agreed. "Elon has the incredible ability and determination to work and work on an idea until he has the solution," Kimbal Musk said. "If he believes it's possible – and he always does when it's a problem he's working on – there's no option for turning back with him. When 99.99 percent of people would have given up, Elon finds the solution that amazes everyone around him."[128]

To be more efficient, Elon performs multiple tasks at the same time. When he talks in the phone, he tries to check out an e-mail, look at a spreadsheet, or search for equipment on the Internet. He e-mail during the transition periods, such as walking between meetings or while eating.[71] When Elon is in multitasking mood, someone trying to talk to him has to try multiple times before Elon realizes there's someone else in the same room.[49] "It's helpful to have an iPhone so I can work during the interstitial moments when the kids don't need me," Elon said. "But basically, my life consists of work, kids, wife, and sleep."[433]

Except boiled carrots, Elon loves food, especially from the Indian kitchen.[116] But he doesn't have any time to really enjoy the food. While eating an entire meal in under five minutes, he discusses work related topics. "In the early days, when Elon would have lunch meetings, I used to have to tell people that they shouldn't worry if he'd already finished before they even sat down," Elon's assistant said.[54]

Ambitious people hate the fact they have to sleep. What a waste of time! Elon experimented with how much sleep he really needed. The answer is around six to six and a half hours. "Someone like Elon Musk doesn't sleep much, he's making decisions at midnight, or two in the morning, or five in the morning," a Tesla employee said.[335] To stay awake, Elon drank eight

cans of Diet Coke together with several cups of coffee. “I got so freaking jacked that I seriously started to feel like I was losing my peripheral vision. Now, the office has caffeine-free Diet Coke,” he said.[71]

Elon worked long days. When he came home, he was tired. Because Elon was tired, small problems became large. Elon and Justine began arguing about things like whether Justine read too much, about the house, when the kids should go to bed, or if Justine’s hair should become more blonder.[182]

The first turning point came when Justine was involved in a car accident while driving her Maserati. “There was a crunch of metal as her car plowed into mine, and when we skidded to a halt, my first thought wasn’t, ‘Thank God nobody’s hurt.’ It was, ‘My husband is going to kill me,’” Justine said. “And in my mind’s eye, I could suddenly see myself: a woman who’d gotten very thin, and very blonde, stumbling out of a very expensive car with the front-left wheel smashed in.”[182]

Everyone around Justine thought she was one of those wives with a rich husband who never work. They never asked her “What do you do?” because they assumed she didn’t do anything.[182] In reality, she worked as an author and released the book *Blood Angel* in 2005. It got mostly positive reviews on Amazon.

On one occasion, Justine would meet a friend of a friend at the airport. But they didn’t recognize each other because both had preconceived conceptions on how a rich woman should act and look like. “I heard you were ‘the wife,’ right, and I thought you’d be all la-di-da, loaded down with jewelry and ordering people around and I thought you’d be mean,” the friend of a friend told Justine. “But you came in and you were so down-to-earth and you got out of a cab. I just didn’t think that would be you.”[158]

Justine could sometimes dream of the life she had back in her twenties. She was always broke, she was often lonely, but she was free.[179] And after the move from San Francisco to Los Angeles, it became worse. “I could no longer hide my boredom when the men talked and the women smiled and listened,” Justine said. “I wasn’t interested in Botox or makeup or reducing the appearance of the scars from my C-sections. The men were highly intelligent and successful. The girls were sweet and bright enough, but academia had never been much of a priority. Still, I was struck by how they would break into conversation with a comment so many light-years away

from the sophisticated discourse going on around the table that I would think they were joking. They weren't joking."[140,178,182]

It went so far that Elon and Justine began visiting a marriage counselor. But it didn't work either, so Elon gave an ultimatum. "Either we fix this marriage today or I will divorce you tomorrow," he said. But Justine didn't want a divorce, she wanted a change. "Divorce, for me, was like the bomb you set off when all other options have been exhausted," she said. "We were still in the early stages of marital counseling." Elon, however, took matters into his own hands. On June 16, 2008, Elon filed the divorce.[145] He said it was a mutual decision and the marriage ended because they grew apart and didn't make each other happy anymore.[322]

The problems didn't end here. After the marriage, the board of X.com thought Elon and Justine should visit a lawyer to write a financial agreement. "Since this was not long after the sale of my first company, Zip2, to Compaq, and the subsequent co-founding of PayPal, friends and family advised me to separate whether the marriage was for love or money," Elon said.[440] They signed the agreement two months after the wedding. After the divorce, this financial agreement turned into a battle between their lawyers.

According to the marital agreement, Justine should receive approximately $20 million dollars after tax, half in the form of the house and half in support payments.[440] But Justine explained how she wanted the house, alimony and child support, six million in cash, ten percent of Elon's stock in Tesla and five percent of his stock in SpaceX, and a Tesla Roadster. "I really, really want one," she said of the Roadster.[181] She always cared about Tesla's vision to help transform our society away from its dependency on oil.[136] "Is that what I deserve?" Justine asked. "I don't know. Who exactly deserves that kind of wealth? But based on our life and history together, is that reasonable? I think so. And I want to do good things with it. I don't want hundreds of millions of dollars. I think my ex-husband is brilliant and work like a demon and deserves his success and his wealth."[137,181]

The divorce was public, so everyone knew what was happening. You could even follow the divorce in the CNBC television show *Divorce Wars*. Those who supported Elon compared Justine with a vampire. "Pleased to hear the courts put a stake through the heart of your blood sucking rip off," one said. "He divorced a spoilt psycho and the kids are with him more than her," another one said.[138,143] Those who supported Justine were equally mean

to Elon. “Several awful things have been widely reported that are simply false, but a falsehood uncorrected may as well be truth,” Elon said.[440]

After the divorce settled, Justine got the house, two million in cash minus the legal fees she was responsible for, alimony and child support for seventeen years, no stock, and a Roadster.[134]

A short time after the divorce papers were filed, on July 4, Elon traveled to London to give a lecture at the Royal Aeronautical Society. In the evening, Elon visited the club Whisky Mist.

Elon sat by himself in a corner of the club when Talulah Riley felt sorry for him. She began talking to him. Riley had never before heard of Elon or his companies, so she didn’t know what to think when Elon talked about his cars and his rockets as he always does when meeting women. “Then there he was, smiling this very big smile and talking about colonizing Mars,” Riley said. “He showed me all these pictures on his phone. I thought that these were projects he’d worked on, I didn’t know they were all his own doing.” She left the club after promising Elon she would meet him again for dinner.[129]

The night turned into morning. Riley told her father who she had met and he made a Google search for “Elon + rocket + electric car.” From the search results, her father thought Elon was happily married with five children. “You’ve been picked up by a playboy,” he said. “Text that man, you’re not going for dinner with him, and he’s a bastard.” But Riley called a friend who said Elon was divorced, so she decided to meet Elon again for dinner.[129]

Elon and Riley married in 2010 at the same cathedral as where Madonna and Guy Ritchie married. Riley is a British actress, born in 1985, and had previously acted in the movie *Pride and Prejudice*. When Riley played Annabelle Fritton in the movie *St. Trinian’s 2*, Elon sent her 500 red roses to the set. He also sent every other woman on the set a bouquet so they wouldn’t feel jealous.[129]

During the divorce between Elon and Justine, Riley and Justine began to like each other in a friendly way. “She is, by all accounts, a lovely, bright, and very young person, and better fitted to my ex-husband’s lifestyle and personality than I ever was,” Justine said. “I would rather live out the French-movie version of events (the ex-wife and new fiancee become friends and

various philosophies are pondered) than the American version (one is good and one is psycho, there's a big catfight sequence and someone gets thrown off a balcony) - the latter of which seems vastly overrated."[180]

Elon and Riley's marriage ended in 2012. "@rileytalulah It was an amazing four years. I will love you forever. You will make someone very happy one day," Elon wrote in a Twitter message. It was Riley who had filed the divorce.[117]

After the divorce with Riley, Elon got a reputation for being a playboy. It was after he told a reporter he's 90 percent engineer and 10 percent playboy.[4] It's true he visited the Playboy Mansion since it was only a five minute drive from his house. But in reality, he's not a playboy, and the Playboy Mansion is often rented out for corporate events that don't involve any nakedness. With five kids and several jobs at several companies, Elon is only out once each six month, and then his friends have to drag him out.

Elon work 60 percent of his time available at SpaceX, 35 percent at Tesla, and 5 percent at SolarCity. "It's very busy. I definitely would not recommend it. It is not the path to a happier life," Elon said. "My new year's resolution was to have a little bit more fun this year [2013]."[25,67] In the future, Elon would like to decrease these numbers in a way so he can work 60 percent at SpaceX, 25 percent at Tesla, 5 percent with the rest of his projects – and spend the last 10 percent with his family.[354] "I'd like to dial it back 5 percent or 10 percent and try to have a vacation that's not just e-mail with a view," he said.[25]

So how can someone like Elon motivate himself to work so many hours? "I think you have to enjoy what you are doing," Elon said. "Otherwise, it is hard to do it. There are three things you look for. You have to look forward in the morning to doing your work. You do want to have a significant financial reward. And you want to have a possible effect on the world. If you can find all three, you have something you can tell your children. I would like to allocate more time to dating, though. I need a girlfriend. How much time does a woman want a week? Maybe ten hours?"[51,60] But now he had begun using a product that could help him find a girlfriend. It wasn't a business card with Silian Rail lettering – it was a car.

“If you go to a party and you’re competing with guys with Ferraris, in Los Angeles the one with the Tesla will get her,” Elon said.[205]

Maybe it’s Nikola Tesla who has the answer to why someone like Elon can work so much. “I do not think there is any thrill that can go through the human heart like that felt by the inventor as he sees some creation of the brain unfolding to success,” Tesla said. “Such emotions make a man forget food, sleep, friends, lover, everything.”

Iceberg, Right Ahead

In 1967, the crew of Apollo 1 practiced before a space mission. They were still on the ground, but they sat in the capsule on the top of a Saturn V rocket. “Got a fire in the cockpit,” a crew member reported at 23:31:04. The crew wore space suits, which made it impossible to get out of the small capsule before the fire had engulfed it. No one survived. The memorial plaque on the site where the accident happened says:

IN MEMORY
OF
THOSE WHO MADE THE ULTIMATE SACRIFICE
SO OTHERS COULD REACH FOR THE STARS
AD ASTRA PER ASPERA
(A ROUGH ROAD LEAD TO THE STARS)
GOD SPEED TO THE CREW
OF
APOLLO 1

One of the worst space related accidents took place in China. After the *Challenger* accident in 1986, NASA banned commercial cargo from the Space Shuttle. US satellite companies were now forced to launch satellites with either European or Chinese rockets. The Chinese government decided to lower the prices to about half of the European rockets because they needed the money. As money is often an important factor, several US companies decided to use the Chinese rockets only because it was cheaper.[183]

The rockets launched from Xichang – a remote mountainous region of China close to the border with Burma and Vietnam. Several engineers from Western countries worked in the area to prepare the launch of their equipment. But they didn’t always believe it was a safe working

environment. The Chinese workers were also concerned even though they never dared to say anything.[183]

Because of the hilly terrain, pilots had to perform a dangerous corkscrew maneuver before they could land at the airport. When one westerner asked a Chinese worker if he often flew to the area, the worker replied with, “No. It is too dangerous.” They worked in a recently repaired satellite processing building where a rocket motor had ignited and started bouncing around inside the room. Shortly after liftoff, an earlier rocket had exploded above the launch pad only 3 miles [5 km] from their hotel. To avoid a similar close call accident, they were now forbidden to watch the launch from the roof of the hotel.[183]

In February 1996, the US Intelsat-708 satellite on the top of the Long March rocket was scheduled to launch early in the morning. A US specialist wore his lucky shirt and put 2-yuan coins in his penny loafers for more luck. Because the number three is a Chinese lucky number, the launch was postponed to 3 AM.

All guests and staff were evacuated to a safer place, but the hundreds of residents who lived around the hotel were not evacuated. It was a party atmosphere so everyone were dressed in their best clothes. Other villagers were seemingly unaware of the launch. One sat in front of his house and wove a basket.[183] “Because the launch time was at midnight after two o’clock, we discussed after dinner where we go to watch the launch,” a villager said. “The proposal was the roof of the hostel where it has better views.”[405]

As the day turned into night, the clock turned 3 AM. The rocket launched. An onlooker described what happened after the launch.

> “I got out, turned and ran around the building to my best viewing spot, in time to see the mountain lit from behind, hear the startling rumble and see the rocket emerge. But instead of rising vertically for nine seconds and several thousand feet I saw it traveling horizontally, accelerating as it progressed down the valley, only a few hundred feet off the ground. ‘Wrong way,’ I yelled, and for the next few seconds I was frozen in my tracks.”
>
> “It arced toward the earth and I thought I knew what was coming, but the instant of horror that is burned into memory was not anticipated. A

> tremendous light turned 3 AM into noon. Every tree on the hillside was clear as a knife edge, and the sky reflected a weird glow, a color I can not describe. Many things happened at once. I heard the biggest explosion of my life, I turned and started to run. I saw a friend's face contorted in Oh shit. I heard a smaller and then a larger boom, I left the ground, I was on the ground, scrambling, wondering why I was down there. I heard glass breaking and shit was flying everywhere."[183]

22 seconds after the launch, the rocket hit the ground just across the road from the hotel. The Chinese government claimed the villagers were evacuated before the launch, but the foreign personnel's bus back to the hotel was mysteriously delayed by five hours. Everyone suspected that the Chinese wanted to clean up before they could return to the hotel. When they finally came back, they saw hundreds of Chinese soldiers working in the area. Eyewitnesses have later claimed how they saw trucks that transported human remains.[183] "In my department, a classmate of mine died," a villager said. "Two were seriously injured and nearly died. There were three or four cuts on his face. His neck artery was broken. The soldier pressed on the cut all the way to Xichang City where it was finally stitched."[405]

The official casualties were six dead and 57 injured. That's a realistic number for the casualties among the technical personnel who worked with the launch. It's impossible to say how many local villagers died. The numbers have been estimated by unofficial sources to be hundreds, which would make it the worst disaster in the history of rocket launches.[183]

It was the rocket's flight control system that caused the accident. But a Chinese military official had found another cause. "Everybody knows that when you light the rocket it goes straight up, so, obviously, outside influences had an effect," he said.[183]

No one said that it's safe to launch rockets. "We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win," the former US President John F. Kennedy said.[19]

Space travel will always be a risky endeavor, but you need to take risks to move forward. "In the early days of aviation there was a great deal of

experimentation and a high death rate," Elon said. "We don't want that – the public would not be accepting – but by the same token we can't have a situation where no deaths are ever allowed, because that would put innovation in a coffin too."[316]

One of the astronauts who sat in the Apollo 1 capsule was Gus Grissom. A reporter asked him about the risks of flying a new spacecraft. "If we die, we want people to accept it," Grissom replied. "We're in a risky business, and we hope that if anything happens to us it will not delay the program. The conquest of space is worth the risk of life."[352]

The first man on the Moon, Neil Armstrong, got the question what he would do if the Lunar Module didn't start again after it had landed on the Moon. "Well, that's an unpleasant thing to think about," Armstrong replied. "We've chosen not to think about that up to the present time. We don't think that's at all a likely situation. It's simply a possible one."[16]

Armstrong was negative to SpaceX. Elon said it was a disappointing moment when a hero from his childhood didn't encourage him to pursue his dream. "He has never spoken to us or visited us, and we've made many invitations," Elon said. "I'm optimistic that he will visit us and learn more. We have a photo of the [SpaceX] launch signed by all the Apollo astronauts with the exception of Neil."[316] Unfortunately, Armstrong passed away in 2012 before he had a chance to visit SpaceX.

A rocket can fail in a thousand different ways, but the number one reason is engine malfunctions. "There are a thousand things that can happen when you go to light a rocket engine, and only one of them is good," Tom Mueller said. "We knew it would be hard, but it was harder than we thought."[288]

The third attempt to launch the Falcon 1 rocket occurred on August 3, 2008. "I stood around with the then 350 or so employees, and we cheered the vehicle on as it took off, and as we were watching the mission clock and knew that the stages were about to separate – the video feed was cut," a SpaceXer said. "We knew something had gone wrong in a big way."[404] The rocket had failed for a third time. The first stage had separated from the second stage, but it didn't fall back to Earth. The first stage's rocket engines continued to push the first stage up against the second stage with the result that the entire rocket failed.

After the third launch, SpaceX didn't just lose the rocket. They also lost two of NASA's satellites and the ashes of 208 people whose last wish was to

be launched into space. One of the 208 people was the *Star Trek* actor James "Scotty" Doohan. "Technically, Scotty's ashes did get to space, they just didn't stay there," Elon said.[59,60]

"The mood in the building hung thick with despair," a SpaceXer said. Most employees had worked more than 80 hours a week to make sure the third launch was a success.[404] To lighten the mood, Elon felt he needed to inspire his company with a message. "We knew this was going to be hard, it is after all rocket science," he said. "The most important message I'd like to send right now is that SpaceX will not skip a beat in execution going forward. There should be absolutely zero question that SpaceX will prevail in reaching orbit and demonstrating reliable space transport. For my part, I will never give up and I mean never. Thanks for your hard work and now on to flight four."[60] What he wanted to do was to rally the employees and investors without creating false hope. "You've got to communicate, particularly within the company, the true state of the company," he said.[22]

The outcome of the message was exactly what Elon had hoped would happen. "I think most of us would have followed him into the gates of hell carrying suntan oil after that," a SpaceXer said. "Within moments the energy of the building went from despair and defeat to a massive buzz of determination as people began to focus on moving forward instead of looking back. I wish I had video footage as I would love to analyze the shifts in body language that occurred over those five seconds."[404]

If the fourth rocket failed, SpaceX would die.[25] "When people really understand it's do or die but if we work hard and pull through, there's going to be a great outcome, people will give it everything they've got," Elon said.[22] Everything hinged on the fourth launch. SpaceX had financed the rocket by selling future launches. If the rocket failed again, SpaceX had to return the money. "It would have been over," Adeo Ressi said. "We're talking Harvard Business School case study – rich guy who goes into the rocket business and loses it all."[278]

Another Iceberg, Right Ahead

Tesla Motors began to shiver in 2007. Several Tesla board members became concerned that the CEO, Martin Eberhard, couldn't control the growing company. One of the investors in Tesla did his own cost analysis with the help of external consultants, and he saw that the cost of producing the first version of the Roadster had climbed from $70 000 to at least $130 000.[59] "This CEO [Eberhard] would not admit the problems and ask for help," a board member said. "You must develop commitments from data and set them in reality, not just hope it works out. We did not believe that this registered with him, and the board felt compelled to take action." In a similar way as when Elon agreed to replace himself as CEO of Zip2, Eberhard agreed to join a board subcommittee to search for his own replacement.[196]

Elon thought Eberhard had hidden these cost overruns from the board, so Eberhard had to step down before Tesla found his replacement. It came as a surprise to Eberhard. "My relationship with Elon was really good until the very last minute," Eberhard said. "He might portray this very differently, but he and I were on good speaking terms until the day last August when he called me to tell me I wasn't CEO any more. That was totally unexpected. It was a whack on the side of the head."[205]

In August 2007, Tesla replaced Eberhard with Michael Marks. He would work as an interim CEO until Tesla could find a long-term CEO. Elon knew he couldn't run the company himself – he already worked as the CEO and CTO of SpaceX. Eberhard, now demoted to the president of technology, would still earn the same salary as when he worked as CEO. This position suited him better. "I'm an engineer, not a finance guy," he said. But five weeks later, in October, Marks informed Eberhard he could no longer work in the company because it was unsustainable due to Elon's persistent calls for Eberhard's termination. "I should have been more careful," Eberhard said. "I shouldn't have let Elon take a disproportionate control of the board."[196,208]

Eberhard didn't leave the company unnoticed. He felt he was mistreated. While he tried to lower the costs of the Roadster by using standardized parts, Elon was the one who demanded the more expensive parts. Elon, however,

denied that the changes he made burdened the company.[59] Eberhard thought he had been a scapegoat and sued Tesla. “I am not at all happy with the way I was treated, and I do not think this was the very best way to handle a transition – not the best for Tesla, not the best for Tesla’s customers, and not for Tesla’s investors,” Eberhard said.[201]

75 percent of the lawsuit consisted of attached media articles. The articles consisted of interviews with Elon and contained quotes where Elon said he was the founder of Tesla. You couldn’t find the name Eberhard anywhere in these articles. Eberhard accused Elon of trying to rewrite the history by trying to take ownership of the idea behind the company.[70] The truth was that Eberhard co-founded the company in 2003 before Elon came in as an investor, so Eberhard wanted to be recognized as one of the co-founders. Elon, however, argued that Tesla was just an empty shell when he arrived. “He [Eberhard] had no technology of his own, he did not have a prototype car and he owned no intellectual property relating to electric cars. All he had was a business plan to commercialize the AC Propulsion tzero electric sports car concept.”[230]

Another part of the lawsuit claimed that Elon had lied about how he dropped out from a PhD program and his degree in physics. The lawsuit said:

> In several national publications, Musk has allegedly misrepresented his affiliation with Stanford University, claiming to have “dropped out” of a PhD program at that university when in fact he was never enrolled at Stanford.
>
> Musk has falsely claimed to have a degree in Physics from the University of Pennsylvania that he obtained in 1995, when he in fact has no such degree and the only degree he holds was obtained later than that. Upon information and belief, Musk’s only known undergraduate degree is a Bachelor of Science in Economics, obtained from the University of Pennsylvania in May 1997.[454]

Because of these allegations, Tesla sued Eberhard. “This lawsuit is an unfair personal attack and, more importantly, paints an inaccurate picture of Tesla’s history,” the company said. “This lawsuit is a fictionalized account of Tesla’s early years – it’s twisted and wrong, and we welcome the opportunity to set the record straight.”[208]

Eberhard had a blog called the *Tesla Founder's Blog* where he, among other topics, documented comments from current and previous employees. "The company has changed so tremendously since I started," one blog post said. "It's very secretive and cold now. It's like they're trying to root out and destroy any of its heart that might still be beating." Elon fought back. "I was too busy trying to fix the fucking mess he left," Elon said. "I haven't had time to tell my story. I will say, I have never met someone who is as capable of creating such a disinformation campaign as Martin Eberhard."[196] Eventually they settled through mediation.[54]

When Eberhard worked as CEO of Tesla, he used to question every engineering assumption. It's something you should do when creating a new company. "Technically he [Eberhard] is just brilliant, and he has a tenacity that is unbelievable," an early investor in Tesla said. "He is the guy you want around in those early days when you have naysayers all around." Elon, however, argued that Tesla had to redo everything Eberhard was responsible for. "The real reason that the development of the Roadster cost so much more than can be accounted for by typical entrepreneurial hubris is that we essentially had to spend the development money twice," Elon said. "After Eberhard was asked to step down from the CEO role, almost every major system on the car, including the body, HVAC, motor, power electronics, transmission, and battery pack, had to be redesigned, retooled, or switched to a new supplier."[230]

Marks was motivated to revive the dying company because he was an early investor. The first thing he did was to put together a list, known as *Marks's list*, filled with items that could delay the car. Marks realized that Tesla needed to postpone the production of the Roadster with at least six months. "I postponed anything that wasn't aimed directly at getting the Roadster out the door," Marks said. "If we didn't get that car out, there wasn't going to be a business. There was a lack of knowledge about how long it takes to get a car through tests and manufacturing bugs – this is a very regulated industry. And there was a real lack of recognition of how much it was going to cost."[196,223]

In December 2007, Tesla hired a second interim CEO. They recruited Ze'ev Drori because one of the investors thought Tesla needed someone who wasn't afraid of danger. Drori was born in Israel before he immigrated to the US where he founded Monolithic Memories. When the Yom Kippur War broke out in Israel in 1973 – the same conflict that initialized a global oil

crisis – Drori took the first flight to Israel to fight in the war. He phoned the office and said he would be gone until the war ended. Luckily, the war lasted only 20 days. Drori had also experience from sports cars as he was a racecar driver.[350]

In October 2008, after interviewing more than 20 prospective CEOs, Elon decided to take the job himself. "I wish he had done that earlier," Marc Tarpenning said. "Elon was the perfect CEO – it was bold and out-there."[222] While Elon might have been the perfect CEO, the question was if he really had the time to be the CEO and CTO of SpaceX and the CEO of Tesla. But Elon didn't have any other choice. "I had to choose to either let Tesla die or run it personally," he said. "At considerable personal sacrifice, I decided to do the latter. It is a great hardship to run two companies at once – and harder with their headquarters separated by 400 miles [640 km] and in the middle of the worst recession since the Great Depression."[52]

"Don't shield me from emergencies," Elon told his employees. "I want to know the split second they occur, and have the option of taking a hand."[59] He told them he was available 24/7 and they could call at 3 AM on a Sunday morning if they felt it was necessary.[331] "I went from working hard to working ridiculously hard," Elon said.[59] Not strange Justine thought Elon worked too much. "Elon is not afraid of breaking things – he will break himself if he has to," Justine said.[278]

Automotive news interested most Tesla engineers. When they woke up one morning in October 2008, they went to their computers, opened an Internet browser, went to their favorite automotive blog, and read that Tesla would reduce the number of employees. "There will also be some headcount reduction due to consolidation of operations," the message said. "In anticipation of moving vehicle engineering to our new HQ in San Jose, we are ramping down and will close our Rochester Hills office near Detroit. Good communication, tightly knit engineering and a common company culture are of paramount importance as Tesla grows."[227] The number of employees decreased from 380 to 300, and Tesla canceled the plan to build a new factory in New Mexico as well as the plan to produce battery packs in Thailand.

Tesla needed to raise more money from investors. But the automotive industry wasn't the hottest investment after the credit crisis of 2008 when companies like General Motors and Chrysler struggled for their survival.

October 2008 was the worst month for the auto industry in 25 years.[49] “It’s not an understatement to say that nearly every business will be impacted by what has unfolded in the past weeks, and this is true for Silicon Valley as well,” Elon said.[221]

Elon phoned his brother Kimbal Musk, who now lived in Boulder, Colorado. Kimbal recalled how he could hear the stress in his brother’s voice. “You really think it’s rational to put more money in?” Kimbal asked. “We’re so close, Daimler’s almost there, the Roadster’s almost there. We can’t quit now,” Elon replied.[210]

This was Tesla in December 2008. They needed at least $40 million to survive. Tesla had no money and couldn’t pay the bills, they couldn’t sell more cars because the cars were not yet profitable, the largest investor didn’t want to keep Elon as CEO, and Goldman Sachs failed to raise more money for Tesla.[413]

As a last resort, Elon decided to invest the last pieces from his past fortune in Tesla. “Just to keep Tesla alive, I had to wire three million dollars personally, with no guarantees of anything, basically wire the funds and say ‘Use it,’ or else we wouldn’t be able to make payroll,” Elon said. “Either I went all in, or Tesla dies. I didn’t want to look back and say there was something more I could have done and didn’t. I never thought I’d have to invest as much of my own money [in Tesla] as I did. I thought I would invest $20 to $30 million of my own funds and in the end I had to spend $70 million, which was quite painful.”[55,235,331]

Because Elon invested more money, the other investors, who had been negative to Tesla’s future, became more confident and followed him. “When you define an investment and say: ‘The train is leaving the station, do you want to be on that train?’ is a different question to investors than ‘Do you want to start with a black sheet of paper, you don’t know if others will follow, and make an offer,’” an investor in Tesla said. “All of sudden, fear shifted to greed, and everyone wanted a piece.”[413] The investors finally agreed to invest more money on Christmas Eve 2008. If they hadn’t agreed before the day was over, Tesla would have gone bankrupt. But Tesla wasn’t saved – they had only bought some time[389]

In the documentary *Revenge of the electric car*, Elon and his team are walking around in a storage area stuffed with assembled Roadster. But all cars had some minor fault or missing parts, so they couldn’t be delivered to

their owners. “We had bought 80 percent of the parts for hundreds of cars, but since we didn’t have the remaining 20 percent of the parts, we couldn’t ship [the cars] and get paid for it,” Elon said.[196] When the cars began rolling out, Tesla had to recall most of them to fix loose bolts in the wheel hubs. “It’s bloody Lotus’s fault, but it’ll be seen as Tesla, the upstart car company, doesn’t know how to make cars,” Elon said.[59]

One famous customer who had ordered a Roadster was the actor Leonardo DiCaprio. He became interested in environmental issues when he was invited to the White House where he listened to a speech by Al Gore. Later at the Oscars, he arrived in a Toyota Prius to market the car. “I’m photographed constantly by paparazzi when I leave my home so it was just a responsible thing to do as an environmentalist,” he said.[371]

The customer confidence was now in free fall. DiCaprio and other famous customers like George Clooney, Matt Damon, and the founders of Google didn’t get their cars.[59] They had already paid a large deposit several years ago. One customer had even visited Elon’s home to give him an envelope with cash to pay for a Roadster.[159]

When one customer ordered a Roadster, his friends said he would never see his car because Tesla was just a Ponzi scheme. Now the customer thought his friends were correct and he had lost his money. “Right now, we are facing an issue which is a crisis of confidence among our customers,” Elon said. “You can only tell them delay so many times and they start thinking ‘man, is this company ever going to get me a car?’“[331]

Michael “Flea” Balzary from the rock band Red Hot Chili Peppers ordered his Roadster after watching the documentary *Who killed the electric car?* “So then nearly a year goes by, and still no car, I started to get a little antsy, still excited, but wondering if Tesla might actually be the name of some farmland I bought on an island of Nova Scotia somewhere,” he said.[271]

To make matters worse, the popular television show *Top Gear* reviewed the Roadster. The review began with a drag race competition between a Roadster and a Lotus Elise. The Roadster won. “Not bad for a motor that has the size of a water melon and only has one moving part,” the reviewer, Jeremy Clarkson, said. He then went on arguing how it’s cheaper to charge an electric car compared with to fill up a gasoline car, and that the weight of the batteries affected the steering.

After the promising start, the review went downhill. “Although Tesla say that it will do 200 miles, we worked out that on our track, it will run out after just 55 miles,” Clarkson said. They also showed how the Roadster stopped on the test track. Clarkson said it would take 25 days to charge a Roadster with electricity from a small wind power station, and you have to buy two Roadster – one should remain in your garage where it can charge.[220]

The interesting part of the *Top Gear* story is that the Tesla employee who delivered the cars happened to notice a script from *Top Gear* laying around. Written before the cars were tested, the script told Clarkson to say, “In the real world, it doesn’t seem to work.”[276,326] So Tesla fought back. “The breakdowns were staged and the statements are untrue,” Tesla wrote in their blog before they sued *Top Gear*.

The television show argued the 55 miles was correct if you drive it with full speed on their test track, and it will do 200 miles if you drive it in a normal way on the road. Your driving style will affect the range of an electric car. If you have a cruise control, the vehicle will not go faster than intended, and it will also avoid the small and unnecessary accelerations and decelerations that consumes more energy.[226]

Despite the negative review by *Top Gear*, Elon enjoys the television show and thinks Clarkson can be very funny. “Clarkson’s show is more about entertainment than it’s about truth,” Elon said. “I think most people realize that, but not everyone.” Clarkson is a man who tends to dislike electric cars and American cars. Tesla is an American car company that manufactures electric cars. It’s a recipe for disaster if you want to get a good review by *Top Gear*.[418]

When you don’t think it can get any worse, it can. One Tesla employee leaked information to the popular blog *Valleywag*. He talked about how the morale had sunk and how Tesla took deposits from customers when the company had only $9 million in the bank account. Would these buyers really get their cars? “As a longtime employee of Tesla Motors, yesterday was the worst day since I joined Tesla Motors four years ago,” the leak said. “I cannot conscientiously be a bystander anymore and allow my company to deceive the public and defraud our dear customers. Our customers and the general public are the reason Tesla is so loved. The fact that they are being lied to is just wrong.”[430]

To find the employee who leaked the information, Elon hired a team of computer forensics who went through the computers. Another investigator

took fingerprints off a printout near the copier used to leak the email.[428] They found the leak and he was fired.

The leak was positive to Tesla and he really liked the Model S, but the ongoing events had affected him. “The past month has been very difficult, sitting through planning meetings and watch employees make in or out of the layoff list,” he said. “It is so sad to lose 87 employees in a week. I became very upset and did the very foolish thing of writing a letter to Valleywag. I have never thought this letter would create such an upsetting situation for Tesla Motors and I should have never sent that letter.”[429]

Tesla suspected there was more than one leak. To find out, Elon sent to several employees slightly altered versions of the same e-mail. In one version, he wrote “I am” and in another version he wrote “I’m.” Ironically, the e-mail began with Elon saying, “I’m a big believer in trusting employees.” He continued the e-mail by describing that he was concerned about the leaks and how it really hurts free communication when minor issues are leaked and then blown up by the media. “It is nutty that a company like Tesla, which is doing really well right now (how many companies can say that they’re sold out through October?) should suffer from misleading articles on blog sites that would have no credibility, but for a purported inside leak,” he wrote. “The leaks often aren’t even accurate!”[428]

But Elon had failed to mention his idea to send altered version of the same e-mail to everyone. By an accident, each employee also got the original version of the e-mail attached to his or her individual version. When everyone found out what Elon had tried to do, the situation worsened. “Life for the employees at Tesla Motors has got more depressing over the last few months,” an employee said. “Elon Musk is now spying on everyone.”[428]

Tesla decided to release Model S earlier than expected, and they had a big release party. But Elon was skeptical. “The only sad story is that I’m not looking forward to the party tonight,” he said. “I’m not trying to do this company because I think this is the easiest way to make a buck – I’d be bloody insane. There are many other things I’d do if maximizing my wealth was my objective. The reality is, it’s not fun running a car company and a rocket company at the same time. The amount of work I have is way past the fun point.”[223]

Tesla applied for a loan guarantee from the Department Of Energy [DOE]. This decision would be criticized – not least when Elon took his private jet to Washington. This was after the public had criticized the

executives from the Big Three automakers when they took the private jet to Washington to negotiate a bailout. “Much has been written about my use of a ‘private’ jet, as though this is a personal indulgence or shows that I have some kind of Marie Antionette approach to living expenses,” Elon said. “Last year, I did roughly 200 business trips and spent 500 hours in the air, not counting airport time. In contrast, you could count the number of truly personal trips I did on one hand. If I didn’t need the plane to get my jobs done running SpaceX and Tesla simultaneously, it would have been sold long ago.”[440]

The New York Times columnist, Randall Stross, wanted to rename the loan program to “The Bailout of Very, Very High-Net-Worth Individuals Who Invested in Tesla Motors Act.” The reason why everyone thought this loan would become yet another bailout of the rich was that the government announced it at the same time as they announced the bailout of the other companies. But in reality, the loan was initialized in 2007, before the financial crisis had begun sweeping in.[54] The goal of the loan program was to accelerate the production of fuel-efficient vehicles for mainstream Americans and reduce the nation’s dependency on oil.[275]

While Ford got a $5.9 billion loan from DOE, Tesla got a $465 million loan. Tesla used the money to accelerate the progress of Model S and to build a production facility for electric powertrains. Each company applying for the loan had to prove it had a viable business, thus General Motors failed to get it. Tesla, Ford, and Nissan were the only companies that got it.[54] But Tesla didn’t need the loan from DOE to survive. “There’s a lot of misinformation out there,” Elon said. “We’ll be profitable in July, and we’re already cash-flow positive. We would not need the loan to survive. Randy Stross is a huge douche bag and an idiot. What is he doing picking on an electric car company? Why would he pick on the little guy who is trying to do good when you’ve got egregious waste of money in the tens of billions occurring in Detroit?”[223,231]

“Douche bag” is a common word in Elon’s vocabulary. Elon prepared himself before an interview with the television host David Letterman from the *Late Show*, who was one of the first owners of the Roadster. “If you call Dan Neil a douche bag on national television, I’m going to come out and kick your ass,” Elon’s assistant told him. “But he is a douche bag,” Elon replied. He had become upset when Neil, who worked as a car columnist at the *Los Angeles Times*, gave Model S the nickname glorified golf cart.[59]

Another journalist who made Elon upset was Owen Thomas from the blog *Valleywag*. “The single most tediously mean-spirited person I have ever encountered,” Elon said of him.[223] Thomas wrote the following in an article, “That’s Musk’s version, anyway. I’m skeptical, if only from experience with Musk; when he was running PayPal, I remember him making statements that company insiders told me didn’t match the facts.”[454]

But if someone calls you a thief in public, you have to respond. The problem wasn’t that Elon couldn’t accept criticism. “Don’t tell me what you like, tell me what you don’t like,” Elon always asked when a friend used one of his products.[324] He added that you should always weigh it up since negative feedback isn’t always correct feedback. But there’s a difference between being a critic and being a liar. “There have been hundreds of negative articles, and yet I’ve only spoken out a few times,” Elon said. “I don’t have a problem with critical reviews; I have a problem with false reviews.”[362]

Elon came close to the point where he was about to snap and go crazy. “I’d never seen him so sad,” his mother Maye said. “Everything was collapsing around him.”[54] “For a while there, it looked like I had lost my marriage and all three companies [also SolarCity had problems] were going to die,” Elon said. “At that point, every day was like eating glass and staring into the abyss of death.”[55,210]

Working as the CEO of two companies and taking care of five kids, Elon didn’t have any time to sleep. “I was like, I’m fucked. What am I going to do?” he said. “I never thought I was someone who was capable of a nervous breakdown, but I think I came as close as I ever come on December 22. I think once you snapped, you probably don’t realize it because you have gone insane, and your ability to look in the mirror psychologically is substantially impaired.”[51,331]

When Elon had decided to invest the last pieces from his past fortune in Tesla, he had a few million dollars to cover living expenses. “This should have been fine, as, relative to others with a similar net worth, I don’t spend much money on personal matters,” Elon said. “I own no homes (not even my residence at this point), yachts or expensive artwork. My clothes are mostly

jeans and t-shirts and I almost never take vacations, apart from kid related travel."[440]

But after the divorce with Justine, his expenses increased. In a California divorce, the wealthier spouse has to pay both sides of the battle. The legal and accounting bills for the divorce grew to $170 000 per month. "Journalists were quick to mock the poor 'broke' guy that had $200k a month expenses, failing to note that legal fees constituted the majority," Elon said.[440]

Elon sought comfort in the book *The Hitchhiker's Guide to the Galaxy* where he found the quote "Don't panic." He thought that if you let your emotions take over, they could cloud your decision-making process and cause you to make decisions you'll regret later.[125]

As the troubles with SpaceX and Tesla began at the same time, Elon wondered if he should save either Tesla or SpaceX. In the end, Elon decided not to give up any of the companies. He compared it with having two children in trouble. Would you save just one kid or would you try to save both? "You should not give up unless you are forced to give up," Elon said. "But there are times when you should give up because you are doing something in error, if you are trying to penetrate a brick-wall with your head. If you are convinced that what you are doing is correct, then you should never give up."[360]

What is certain is that Elon never called for higher powers during these years. Elon has only returned to South Africa four times since he immigrated to Canada, and he has never considered himself a South African.[4] But one of the few trips back to his birth country came close to becoming one of his last trips ever.

In 2000, Elon and Justine traveled to South Africa where they visited Pretoria and the Londolozi Game Reserve. During Elon's seventeen years in the country, he never took a malaria pill. On this trip, they took some pills even though they didn't take the pills seriously. Why would they? They were going to spend their time in a low-risk malaria area. What they didn't know was that a recent flooding turned the low-risk area to a high-risk area.[169]

When they came back to California, Elon felt ill and went to the hospital. But the tests for malaria were negative, so he returned home again. But he didn't get better. He returned to the hospital, where the doctors began treating him for malaria. He was less than two days away from being irrecoverable – when the disease would have caused so much damage in his

body that all the doctors could have done was nothing.[169] “Man, that experience was no fun at all, but it does tend to sharpen your goal-setting,” Elon said.[56]

Elon never prayed when he almost died of Malaria and he is not a religious man.[341] He once got the question if he thought there’s some master intelligence. “I think probably not because then you have to say: Where does the master intelligence come from?” Elon replied. “So it sort of begs the question. So I think really you can explain this with the fundamental laws of physics. You know its complex phenomenon from simple elements.”[354]

Revenge

Henry Ford had a saying, “When everything seems to be going against you, remember that the airplane takes off against the wind, not with it.” After the credit crisis of 2008 hit the world economy, Elon realized how he could use the recession to his advantage. “The economy is shit,” he said. “Do you realize what that’s going to do to the value of secondhand machines? They’ll be in the toilet. We can get an EB welder on-site.”[49]

It wasn’t the loan from the Department Of Energy that saved the empire, those money arrived as late as 2010. What really saved the empire was when Daimler invested in Tesla and when Dell acquired Everdream. From Everdream, Elon got $120 fresh millions. Two of his cousins had founded Everdream, and he had earlier invested in the company and was now a major shareholder. “That money arrived in early 2009 and replenished the coffers. Thank goodness, man,” Elon said. “Those were dark days. I think I still have some emotional scar tissue. Just thinking about that time stresses me out.”[51,54]

Known as the Tesla Deathwatch, the blog *The Truth About Cars* [TTAC] had begun a countdown until Tesla would die. “It seems like they may be waiting for a while,” Elon told the bloggers when it looked like Tesla would survive. “We’ve confounded the critics at every turn. At a certain point, people have to get tired of being wrong.”[331,34]

TTAC stopped the countdown when Tesla delivered Roadster number 100 to its owner. But they were still negative to Tesla’s future as a profitable car company. “I still believe Tesla doesn’t have a hope in hell of staying in business,” they wrote. “But it will take a while for that to play out. I made my point: they’re a company fueled by tree-hugging hype rather than solid engineering or accountability.”[203] This is a common misunderstanding. The truth is that Tesla doesn’t manufacture electric cars primarily because of the environment, Tesla manufacture electric cars because the world is running out of oil.

The first customer who got his Roadster was Elon himself. It was delivered in February 2008. “It’s an awesome day. It feels like victory,” Elon

said. What do you do in Silicon Valley when you, after years of toil, receive delivery of your very first product? “You take a victory lap down University Avenue in Palo Alto of course,” a Tesla employee said. “To me this is the Silicon Valley version of John Travolta going for a strut at the end of the movie Staying Alive.” So Elon jumped in the car together with JB Straubel and drove away closely followed by four Roadster prototypes.[273]

Elon began using the Roadster as his daily driver between his home in Bel Air and SpaceX in Hawthorne. “It has been a blast driving my Tesla Roadster every day for the past several weeks,” Elon said. “Reaction from driving the car around Los Angeles has been great. It’s thumbs up wherever I go – something that never happens when I’m driving the Porsche. A big advantage of the Roadster is that I can show up to an event like Global Green or Conservation International in a hot sports car and actually get a better reaction than if I drove a Prius. The Roadster has twice the energy efficiency of that gas hog.”[243]

While the second Roadster was delivered to Elon’s friend, the former CEO, Martin Eberhard, had to wait for the third Roadster. Eberhard had actually ordered the second Roadster, but it was delayed, so the third Roadster delivered would be his. His car was silver colored with two orange racing stripes.

Before Eberhard’s Roadster was delivered, Tesla test-drove it on the highway. The technician who drove the car collided with a truck, thus the Roadster had to be towed back for reparation.[196] A total of 75 parts were replaced before it finally could be delivered to Eberhard. “For my part, I am a free man,” Eberhard said. “I will probably spend the next six months thinking about my next venture. I still care about the things that concerned me five years ago, so I will look for another opportunity to contribute to solving the dual problems of global warming and oil dependency.”[201]

As the Roadster had been delayed by one and a half years, the question was if the customers still liked the car? But the furious customers calmed down. Most customers believed in Tesla, so only about 30 out of 1 000 customers asked if they could get their deposits back. “Nearly three years after ordering the car, and a year and a half after its initially promised delivery date, it arrived,” a customer said. “It was worth waiting for. I would love if Elon Musk went down in history alongside Henry Ford for doing this thing.”[196]

Other customers had only minor complaints. The lead singer in the rock band Red Hot Chili Peppers, Anthony Kiedis, said the only problem with his Roadster was that he now never drove his Porsche.[59] “To be honest, the only real complaint I have about the Roadster is that its windshield is perpetually filthy,” the former interim CEO, Michael Marks, said. “Think about it: If you don’t stop at a gas station, when would you clean your car’s windshield?”[242]

One customer who wasn’t satisfied with the Roadster was Arnold Schwarzenegger. The reason wasn’t because he didn’t like the car’s performance, but because his body was simply too big to be able to drive the small Roadster. He was after all used to driving the former military vehicle Hummer. Instead, Schwarzenegger decided to order the larger Model S.[59]

It’s unclear what George Clooney thought about his Roadster #8. He wore a Tesla cap so he didn’t dislike the company, but he decided to auction off his car for charity.[216]

Tesla manufactured a total of 2 500 Roadster, and the demand for Model S looked good. “The day they started selling the Model S, we walked into the Menlo Park store at 10 AM with $40 000 cash in my wife’s purse,” one customer said. “It was in large packs of $100 bills. That got their attention.”[228] The reservations poured in. “Not bad!” Elon said. “Not bad for the worst automotive environment since the Great Depression, all the stories about Tesla supposedly going bankrupt, people’s net worth having taken a giant kick in the balls, and the fact that the car isn’t coming out for two and a half years.”[59]

Everything looked good, but Tesla would still need more time to prove they could make cars for a profit. “I’ve been going past the red line on the gauge for a while now,” Elon said. “It’s honestly not been fun, but I have to continue for a bit longer, because for Tesla in particular, we’re at the stage where the company’s survival is in question.”

Those who criticized Tesla had a point. The last successful car company in America was founded in the beginning of the 20th century. Both John DeLorean and Preston Tucker brought cars to the market, but they were unable to scale up their production and reach profitability.[210,316] The manufacturing of the DeLorean by DeLorean Motor Company began in 1981, but ended in 1982 after 9 000 cars were sold. Tucker Car Corporation manufactured only 58 cars between 1947 and 1948.

To secure the future by increasing the revenues, Tesla wanted to sell their technology to other car companies. Their first target was Daimler – a German company founded by Gottlieb Daimler. Only a few months after Carl Benz, who demonstrated a combustion engine for vehicles in 1885, Gottlieb came up with a similar combustion engine. Carl, however, was the one who patented the engine in 1886.[383]

But how would Tesla convince the Germans? Tesla came up with the idea to rebuild a tiny Daimler Smart car by equipping it with their electric motor and battery pack. “We need to make an electric Smart car in six weeks. Can you do it?” Elon asked Straubel. He accepted the challenge. This was during the development of the Roadster, so Tesla had to use some engineers from the Roadster to work with this new project. Rebuilding the Smart became a gamble, but Elon thought if they could prove themselves to Daimler, they could win a valuable contract. They had to try. This could validate Tesla in the eyes of the world, and they needed the cash.[210]

The Smart wasn’t for sale in the US, so they had to send someone to Tijuana, Mexico, to buy one and bring it back. A Tesla engineer had a friend who spoke Spanish and could travel down to pick up the car, but he needed money to pay for it. “I need $20 000 in cash in a bag right now,” Straubel told the finance department. “We’re sending someone to Tijuana to buy a Smart car.” Three days later, the Smart arrived to the Tesla facility.[210]

Rebuilding the car in six weeks wouldn’t be an easy task. When they became tired, they slept underneath a stair. Despite the low odds, the Smart was ready at exactly the right moment. Straubel sat down in the driver’s seat, floored the pedal, and the Smart rocketed out of the garage. It used a modified version of the Roadster’s engine, so the front wheels of the much smaller Smart lifted from the ground and the rear tires left black marks on the workshop’s floor.[210]

The Daimler executives arrived to Tesla. After a PowerPoint presentation, the executives from Daimler were not convinced. “Everything works great on PowerPoint. You can make anything work on PowerPoint,” Elon said. “If you have a demonstration model, even in primitive form, that’s much more effective in convincing people.”[63]

Daimler didn’t yet know that Tesla had modified a Smart, so Tesla showed them what they had done. “We’ve actually got something to show you. It’s electric. We put in a Tesla battery and motor,” Elon told them. After a test drive, Daimler was ready to explore a partnership. In 2009, Tesla got a

$40 million contract to manufacture 1 000 battery packs for Smart cars and Daimler bought 10 percent of Tesla for $50 million.[198] “Tesla enables us to skip a generation and get into electric as fast as possible,” Daimler said.[59]

But Daimler wasn’t the only car company that was interested in Tesla’s technology. “That was Akio Toyoda’s office. He called and said he’d like to consider being friends,” Elon said after he got the phone call from the CEO of Toyota.[225] They set up a meeting with Toyoda who wanted to discuss business opportunities. To show Toyota they were serious, they learned everything about the fine points of Japanese business etiquette, including how to bow the Japanese way.[210]

The breakfast meeting took place in Elon’s private home in Bel Air. Only minutes before the meeting began, the Tesla team saw how Elon walked out of his house. To mark the occasion, he wore a Halloween joke tie decorated with pumpkins, skeletons, and fake blood. Everyone thought Elon had finally gone crazy and now he would ruin everything. Then, suddenly, Elon looked up with a large smile. “I got you guys,” he shouted. Elon wanted to reduce the tension everyone felt before they would meet the president of the world’s largest car manufacturer.[210]

Toyoda arrived with a convoy of Toyota Sienna minivans and a Lexus limousine. Bodyguards stepped out of the vehicles, followed by Toyota executives and Toyoda himself. Elon could see how Toyoda looked at a Roadster, so he asked if Toyoda wanted to drive it. Toyoda was a certified test driver and had competed in the 24-hour Nürburgring endurance race in Germany. With ease, Toyoda drove the Roadster around the hilly area around Bel Air. Elon tried to focus on the conversation with Toyoda who said he wanted his company to become more entrepreneurial. Toyoda admired how Elon had managed to develop the Roadster and he thought it seemed like a good car.[210]

When they came back, they had a short meeting before Toyoda decided to cancel his schedule for the rest of the morning. He wanted more of the Roadster. Elon decided to show him the SpaceX factory, so they took a Roadster and drove there. At the factory, they watched rocket launch videos while eating frozen yogurt.[210]

Four weeks later, Toyota decided to invest $50 million in Tesla. They wanted Tesla to develop the second generation RAV4 EV – the former competitor to the EV1 and loved by the actor Tom Hanks. “It’s a great honor

for Tesla to work with a company like Toyota, which is really one of the leaders in the world and a company I personally have long admired," Elon told the audience of the press conference where the collaboration was announced. The next on the stage was Toyoda himself. "Mr. Musk kindly gave me the opportunity to drive one of Tesla's electric vehicle," he said. "Not only was I impressed by Tesla's technology, but I also felt their energy seeing that they made their vehicle in an extremely short time. I felt the wind - the wind of the future. While driving I talked with Mr. Musk and again I was moved by his dedication to Toyota's approach to making things."[448]

It may first sound like it's the wrong strategy to sell Tesla's technology to other car manufactures when Tesla could sell the cars themselves. But you can't compare Tesla's existing cars with the RAV4 EV or the Smart.[225] Tesla's strategy is similar to the strategy used by Apple. What Apple did was to make sure their software in the competing products didn't compete with Apple's products. Apple wanted others to use their technology to see how great it is. The media library and store iTunes used to be exclusively for Apple computers, but Apple decided to let Windows users install iTunes, and the rest is history. How many people use iTunes today?[238]

"Over time my focus has shifted from engineering, which is kind of my intrinsic forte, to supply chain, production and now service to make sure that people have a really great experience," Elon said. "It's not my natural predilection, but it is the thing that needs to be done."[194] To service Tesla's customers and to find new customers, Tesla needed stores similar to the Apple Stores. "The reason I mentioned Apple as an influence is that their stores are beautiful and stylish, but also simple, fun, and friendly at the same time," Elon said. "Those qualities are what we want to see in our Tesla Stores. We will put as much energy into making our stores look good as we do with our cars."[245]

Because the Tesla Stores and the Apple Stores would be similar to each other, Elon contacted George Blankenship. He had worked for the global clothing store GAP before he invented Apple's retail strategy.[51] Blankenship retired from Apple in 2006 and now he worked as a consultant. He began receiving e-mails with the topic "Elon Musk would like to meet you" or "Elon Musk would like to talk to you." As he had never before heard of this Elon Musk, he didn't bother to read the e-mails. "When you're in real estate

you get e-mails like that ten times a day," Blankenship said. "People want to talk to you about every little shopping center they have everywhere in the world. I kept deleting the e-mails."[238]

Several years earlier, Blankenship was told that Steve Jobs had called him. But he thought it was a joke and almost hung up the phone before someone stopped him. Maybe he remembered the first call from Jobs when Blankenship one day decided to read the e-mails from Tesla. "Elon Musk would like to speak to you about the things you did at Apple. Please give me [Elon's secretary] a call," the e-mail said. He called Elon's secretary who put him through to Elon. "Can I see you tomorrow?" Elon asked. "I have to meet at Cape Canaveral tomorrow with Obama at noon and we're doing a presentation. The airport is going to be closed until five. I could get to you for six o'clock tomorrow." Blankenship replied that he could. When they met, Elon persuaded Blankenship to meet some people and test drive the car. After 60 seconds behind the wheel, he knew he had to join Tesla. In 2010, Tesla hired Blankenship as a manager of the new Tesla Stores.[238]

People are still uncertain about what an electric car is, so the goal of these stores is to change people's perception. If someone sees an electric car, they should see a car – not a strange result of a science experiment. When gasoline cars were new, they were considered toys for rich people. The famous banker JP Morgan refused to invest in Ford because he thought exactly that. "When I joined Apple there was one thing that most people knew about Apple: They didn't want one," Blankenship said. "It was for a few crazy people and some creative people."[238]

A computer store couldn't explain Apple's products. Apple didn't want their products to sit on a shelf between a Dell and a Compaq while a salesperson, who didn't have the knowledge to explain why Apple's products were different, just wanted to sell any computer. "All the salesman cared about was a $50 spiff," Steve Jobs said. "Unless we could find ways to get our message to customers at the store, we were screwed."[3]

In a similar way as Apple, Tesla didn't want a Model S to sit between a General Motors and a Ford. "Existing franchise dealers have a fundamental conflict of interest between selling gasoline cars, which constitute the vast majority of their business, and selling the new technology of electric cars," Elon said. "It is impossible for them to explain the advantages of going electric without simultaneously undermining their traditional business."[244] The problem is that auto dealers get most of their revenues from servicing the

cars, and an electric car requires less service than a gasoline car. “It’s harder to sell and they make less money from servicing so for sure we will be the last thing they sell,” Elon said.[366]

When we visit a car dealer, we have already decided which car to buy. It’s often a gasoline car with the same brand as the car we already own. So the Tesla Stores had to be close to potential customers in malls and at similar locations. It’s exactly like the Apple Stores. “We may not be able to get them to drive ten miles to check out our products, but we can get them to walk ten feet,” Jobs said. “If they’re passing by, they will drop in out of curiosity, if we make it inviting enough, and once we get a chance to show them what we have, we will win.”[3]

In 48 US states, it’s illegal for a car company to own the dealer of the cars sold, so these stores have caused some stir within the auto industry. The idea behind the law is to prevent automakers from killing competition and driving independent franchises out of business. “Franchised dealers can’t compete with manufacturer-owned businesses because they can’t spend as much on facilities or advertising,” a New York dealer said.[204]

To go around this law, not all Tesla Stores are selling cars. Some are called galleries where you can’t buy a car. When you are ready to buy a car, you have to go home and order one on the Internet. The question is if Tesla can educate a customer without trying to sell a car? Tesla said they could and were sued by the National Automobile Dealers Association. “The dealer association is a very powerful lobby on the local level,” Elon said. “Really powerful. And we’re a tiny little mouse compared to them on the level of politics. Hopefully the right thing will happen.”[194]

In 2010, Tesla became the first public American car company since Ford in 1956. Marking the first day of trading, Elon rang the bell at Wall Street together with his family.[54]

The television show *Mad Money* with the host Jim Cramer analyzed the company. “You don’t want to own this stock,” Cramer shouted as he always does. “You don’t want to lease it. You shouldn’t even rent the darn thing.” Elon replied to the criticism in an interview. “Yeah sure Jim, you know we are not Bear Stearns, but I think that we are going to do okay,” Elon said. “I think that Jim recommended Bear Stearns, so frankly, he’s a contra indicator.”[34] On the March 11, 2008, episode of *Mad Money*, a viewer

submitted the question if he should be worried about Bear Stearns in terms of liquidity and get his money out of there. “No! No! No! Bear Stearns is not in trouble,” Cramer replied. “If anything, they’re more likely to be taken over. Don’t move your money from Bear.” Later the same year, Bear Stearns became one of the companies that didn’t survive the so called credit crisis.[396]

By the end of 2012, it looked like Tesla could become a profitable company. “Overall, I feel Tesla was really kind of past the point of high risk,” Elon said. “And it’s the classic phrase of going through the valley of death – and I feel as that we are through that valley at this point.”[198]

As death was far away, Tesla wanted to expand outside of the US. It’s a big job to get into each market because each country has its own rules for cars. What are the safety requirements? Do you have to sell through a dealership?[200]

But expanding to some countries would be easier than expanding to other. Norway is the country with the most Model S customers compared with the size of the population. The five million inhabitants ordered 1 000 of the 20 000 pre-ordered cars.[202] If that’s not all, the number one customer is also from Norway. A Norwegian who lives above the Arctic Circle, in Narvik, has bought twelve cars from Tesla.[443] There were also reports from Norway that you have to pay a higher price for a second-hand Tesla than for a brand new Tesla. This is because it takes a few months to order a new Tesla and the Norwegians want their cars today.

The European country is also the world’s fifth largest oil exporter, so why are they using electric cars? The answer is that the Norwegians are well aware of peak oil, and they know that their oil production has declined since year 2000.

To motivate people to begin driving electric vehicles, the Norwegians established a number of incentives. “The benefits are too good,” a Norwegian said. “You can take bus lanes, get free parking and it costs very little to refuel.”[378] These incentives seem to work. While three percent of all cars sold in Norway are electric, the same number in US is 0.1 percent. The current number of electric cars on the Norwegian roads today is 7 000, and the total amount of cars is 2.4 million. About 40 percent of those who own an electric car also own a gasoline car. But the goal of the Norwegian Electric Vehicle Association is to have 100 000 electric cars in Norway before year 2020 – the same year as Elon estimated peak oil will happen. These numbers can be compared with the neighboring country Sweden where the incentives

are less favorable. The Swedes have 4.4 million cars, but only 600 of those are electric.

Without much success, the Norwegians have earlier tried to produce electric cars through the company Think Global. For the fourth time in twenty years, the company filed for bankruptcy in 2011. Several experts argued that also Tesla was close to bankruptcy, so the car after the Roadster, the Model S, would never see daylight.

In 2012, Tesla manufactured and delivered the first Model S. The customers were happy and described Elon as the Steve Jobs of heavy industry. Apple's customers are known for loving their products, and Tesla's customers have begun to love their cars – and Elon himself. Probably as the first CEO of a car company ever, Elon was asked to write his autograph on the inside of a Model S.

One of the first customers who bought a Model S was Christian von Koenigsegg, a Swede who like Elon has founded his own car company called Koenigsegg Automotive. McLaren F1 used to be the fastest production car in the world, but Koenigsegg broke that record when their car reached 241 mph [388 km/h]. Von Koenigsegg has been a fan of Elon since 2001 when he heard that Elon was going to build space rockets. After driving the Model S, von Koenigsegg explained that it's inevitable that electric cars will become more popular than cars powered by oil.[447]

The next model from Tesla would be an SUV called Model X, so Model X is not the BlueStar. The history of the SUV [Sport Utility Vehicle] began after the Second World War when large military vehicles were brought home from the battlefields. The upper class used these vehicles when they hunted animals in the wilderness. As the middle class wanted to act as if they were part of the upper class, they also began to use these vehicles when they hunted food in the supermarket.

To save money, Model X has the same platform as Model S. "The Model X is a continuation of the Model S story," Franz von Holzhausen said. "We looked at the segment because it is really demanding and we wanted to break into it with a game changer. Minivans are incredible, they have such a versatile interior but you have to sell your soul to drive one. And SUVs are horrible inefficient in their utilization of interior space. We wanted to merge attractive and usable."[239]

The next model after Model X will probably be the affordable car that Tesla want to build hundreds of thousands of in a few years. You can no

longer buy a Roadster, so Tesla would also like to manufacture another electric sports car. “We will do an electric supercar at some point,” Elon said. “It was going to happen right after the Model X, but it is more important to the world that we do a more affordable electric car.”[434]

But Tesla is also working with several other projects, including an innovative electric truck. “I’m really excited about bringing out a whole series of cars that address a wide range of consumer interests and needs,” Elon said. “I do think it will be interesting to do self-driving cars, perhaps working in conjunction with Google, who’s quite close to us in Silicon Valley. Larry Page and Sergey Brin are longtime friends of mine, so it would be great to work with them, maybe to do self-driving cars.”[193]

Halfway to Anywhere

The Moon Is a Harsh Mistress by Robert Heinlein was one of the two first books in the International Space Station's library. The other book was *Faust* by Johann Wolfgang von Goethe.[171] Heinlein, who was one of the young Elon's favorite authors, said that once you reach orbit you are halfway to anywhere.[301] SpaceX was still far away from anywhere, but their customers believed in them. "The important thing is that none of our customers left SpaceX," Elon said. "They all sort of held the faith. We actually worked closely with our customers, gave them full disclosure. They knew everything we knew as far as the nature of the problem. They knew we weren't trying to give them a snow job or hide anything. I think that was really important."[22]

To survive, SpaceX raised outside capital for the first time. "As a precautionary measure to guard against the possibility of flight three not reaching orbit, SpaceX recently accepted a significant investment," Elon said. "Combined with our existing cash reserves, that ensures we will have more than sufficient funding on hand to continue launching Falcon 1."

One of the investors was Elon's former co-worker Peter Thiel with his Founders Fund, and the other was Steve Jurvetson with the venture capital firm Draper Fisher Jurvetson. "Musk called me around the darkest times," Jurvetson said. "I was a believer all along, and just wanted my partners to let me invest in something this cool. I really like rockets."[300] Jurvetson, who launches small rockets as a hobby, has an office full of space memorabilia. "You can't finesse your way around this stuff," he said. "There's not a lot of room for artistry because the physics will bite you in the ass."[51]

Jurvetson had previously invested in Tesla and became the first owner of the Model S. "I whip out my wallet, where I always keep one check, fill it out for the full price of the car, and then toss it across the table," Jurvetson said of what happened at a board meeting. It stunned everyone. "Well, I guess you get the first car," a surprised Elon said, who got the second car.[228]

Because of SpaceX's unconventional business model, not everyone would be allowed to invest in the company. "When I've recruited investors, I've made sure they're like-minded," Elon said. "SpaceX will create a great

deal of value over the long term, but there will be times when that horizon is beyond what some investors would be comfortable with. I'm going to make sure I have sufficient control of the company to optimize for the very long term."[316]

This is the reason why it will take a long time before SpaceX becomes a public company. "Mars requires developing complex technology over a decade, but market cares about next three months," Elon said.[250] He added that going to Mars will not yield any immediate revenues, so the stock market would say no to make us an interplanetary species.

In September 2008, it was time for the fourth stressful attempt to launch the Falcon 1 rocket. The launch became a success. "It's just a giant kick on the balls of the people who said that we couldn't do it," Elon said. "A friend of mine wrote to remind me that only 5 of the first 9 Pegasus launches succeeded, 3 of 5 for Ariane, 9 of 20 for Atlas, 9 of 21 for Soyuz, and 9 of 18 for Proton. Having experienced firsthand how hard it is to reach orbit, I have a lot of respect for those that persevered to produce the vehicles that are mainstays of space launch today."[282]

Athletes tend to be superstitious. It's common to hear how a soccer player always wears the same underwear because it brings luck. What Elon did before the first successful launch of a rocket from SpaceX was to bring his kids to Disney World where they took a ride in the roller coaster Space Mountain. Like the soccer player, Elon now believes there's a connection between Space Mountain and a successful rocket launch, so it has become a tradition to visit Disney World before each launch.[420]

After the successful launch of Falcon 1, SpaceX had now done something only nine nations and the European Space Agency done before. "Unlike North Korea, whose rockets actually get worse each flight, the Falcon 1 flights got successively better," Elon said.[56] This was a quote from a time before North Korea claimed they had successfully launched a satellite into space. Elon has made many mistakes, especially in his first companies, but he always tried to learn something from each mistake.[67] "My biggest mistake is probably weighing too much on someone's talent and not someone's personality. I think it matters whether someone has a good heart," he said.[410]

Elon was once asked how he is able to do the things that the government has found itself less able to accomplish as quickly? "Well, one way to think

of government is to think of it as essentially a large corporation," Elon replied. "Generally, large corporations have a harder time with radical innovations than smaller companies. There are some exceptions to that rule, like Apple, but it is generally true that the larger a company is the harder it is to execute innovation."[451]

When discussing the benefits of a small company, and a small government, Elon compares West Germany with East Germany and South Korea with North Korea. In these countries, the same people live but different system of government control them, and as a result, they have different standards of living. In West Germany, the economic output per capita was about five times higher than in East Germany. "And it's not like West Germany was particularly capitalist, they were a lot more socialist than we [US] are," Elon said.[359]

Because Elon believes in a small government, he questioned how much a president could affect the economy. "The reality of being a president is that you are like the captain of a very huge ship and have a small rudder," Elon said. "If there was a button that the president could push that said 'economic prosperity,' he would hit that button really fast. You could measure the speed of light by measure how fast they press that button."[363]

But he's still positive to some politicians.[98] "I believe that the right way to win on a cause is to argue the merits of that cause," Elon said. "This statement may surprise some people, but my experience is that most (not all) politicians and their staffs want to do the right thing and eventually do."[386]

Elon's favorite American president is Ronald Reagan, who was the president between 1981 and 1989. "I think Reagan was great," Elon said. "Reagan was a smart man. The big difference between President Bush [George W Bush] and Reagan is that Reagan actually had strong intellectual underpinnings for his decisive actions. He read. He read a lot of books. He thought deeply about the subjects. And particularly prior to the stroke, his writings were actually quite smart."[454]

Because Elon believes in a small government, he was criticized when Tesla accepted a loan from the government. But back in 2008, we experienced the worst period since the Great Depression in the 1920s. When a company requires an enormous amount of capital, like a car company does, then he argued it made sense to accept a loan from the government.[340]

What a government is good at is to fund basic research - not rapid advancement of technology. “To have things takeoff, you’ve got to have commercial companies do it,” Elon said. “The government was good at getting the basics of the Internet going, but it languished. Commercial companies took a hand around 1995, and then it accelerated.”[316]

Like the Internet, the US government funded the basic rocket research, and now can private companies, like SpaceX, use knowledge from that time. “We’re standing on the shoulders of giants,” Tom Mueller said. “With the Apollo program they learned so much. And we can get access to all that. We use that tremendously. A private company in a vacuum could not do what we did.”[288]

NASA and SpaceX are not competitors and Elon thought NASA is not responsible for the state of space being at the same level as in the 1970s. “The public is asking NASA often to have a perfect track record and a perfect safety record,” he said. “By driving this private space mission forward, I hope for changes for NASA, for it to receive a clear and pressing mandate for a human base [on Mars].” Because the government is not good at innovation and cost optimization, it’s better if NASA sets the goals. According to Elon, NASA should say, “This is what we need to achieve,” and then it’s up to private companies like SpaceX to figure out the best solution to achieve the goal.[286]

It’s no longer possible to purchase payload on the Falcon 1 - SpaceX replaced it with a larger rocket. It may sound strange to first work for six years and spend all your money, and then just scrap the rocket when it’s finally ready. But SpaceX’s goal is not to just launch rockets – they want to do it cheaply. And to do it cheaply, they needed a larger rocket that could carry more cargo.

SpaceX planned to develop a Falcon 5 rocket with five engines in the first stage, thus the 5 in the name Falcon 5. But the Falcon 5 had the same size as another future rocket. The only difference between them was the amount of engines. So SpaceX decided to skip Falcon 5 and immediately begin developing Falcon 9.

The Falcon 1 is comparable to a smaller aircraft. But if the Falcon 9 was an aircraft, it would be a 747 Jumbo Jet.[52] Higher than the Statue of Liberty, the Falcon 9 is an 180 foot [55 m] tall rocket. The rocket’s diameter and

length were optimized in a way that a truck can transport the rocket on a normal road. SpaceX planned from beginning that astronauts would be able to fly with it in a capsule on the top of the rocket, so Falcon 9 had to be more reliable than Falcon 1.[288]

Nine engines in the first stage led to criticism on what would happen if an engine is switched off after the launch. And what would happen if an engine explodes? Wouldn't it be better to have fewer, but larger engines? During the space race, the Saturn V rocket had five engines in the first stage, and the Soviet version of the Saturn V, the N1 rocket, had 30 engines in the first stage. Because of the complexity with so many engines, the N1 failed four times, and the launches ended with a RUD [Rapid Unscheduled Disassembly is space-industry parlance for explosion].

But the Russian engineers improved N1's engines after each failure. Just before they would have worked, the Soviet government canceled the program. They disassembled the remaining rockets and some parts became pigsties. But they kept the engines, and the American company Orbital Sciences would years later purchase them for use in the Antares rocket.

SpaceX designed the Falcon 9 to fly despite an engine malfunction. One engine can explode without affecting the other engines. Like in an airliner, a protective sheath enclose the engines, so a fire or explosion won't affect the rest of the rocket. Depending on where the rocket is on its way to space, the Falcon 9 can lose three engines and still arrive to its final destination. "As long as you are very careful about ensuring that a problem with one engine cannot cascade into problems with another engine, more is actually better," Elon said.[350]

SpaceX moved the launch operations from the Kwajalein Atoll to Cape Canaveral in Florida, where NASA launched most of its historical rockets. Several companies are launching rockets from the same area. The area designated to SpaceX is the same as where the old Titan IV rockets launched until 2005. SpaceX leased Space Launch Complex 40 at the Cape Canaveral Air Force Station from the military. NASA is present in an adjoining area called Kennedy Space Center. The unfortunate astronauts of Apollo 1, who died in a fire, practiced at Space Launch Complex 34.

Due to safety and security reasons, a large area of Cape Canaveral is closed off from the public, but not from all inhabitants. Before the Space

Shuttle landed after a mission in space, the largest problem was clearing the runway from alligators who improved their tan. There are more than fifteen varieties of endangered species watching rocket launches from the front row.[291]

Close to the launch site, there's a control room where SpaceX supervises the launch of the rocket. SpaceX decided to build the control room outside of the main gates to make it easier for civilian customers to follow their cargo's journey to space. This control room shouldn't be confused with the mission control room inside of the SpaceX factory where the rocket after the launch is monitored.[333]

In a square around the launch pad, there are four large lightning towers protecting the rocket from lighting strikes. Next to the launch site there's a sphere holding 100 000 tonnes of liquid oxygen. SpaceX bought the old sphere from a scrap yard for a dollar over scrap.[298]

The Falcon 9 is assembled horizontally, so there's no need for a vertical assembly building like the huge building seen in Cape Canaveral from miles away. The vertical assembly building used by NASA could fit four raised Saturn V rockets, and was so large that rain clouds formed below the ceiling on humid days. When the 30 tonnes heavy Falcon 9 rocket is prepared before launch, it lies on large dollies attached to a rail making it moveable by just four people. The rocket can also rotate around its axis, like when a chicken is barbequed, to make it easier for the SpaceXers to access all parts. When the rocket is ready to fly, two large cranes lift the rocket up to the transporter-erector vehicle. This vehicle carries the rocket to the launch site where it's raised to a vertical position.[334]

In the same way as we need both commercial and military airports, there's a need for both commercial and military spaceports. SpaceX would like to launch rockets from three locations. The current locations are Cape Canaveral in Florida, which is an Air Force Base, and the Vandenberg Air Force Base in California. Because both launch sites belong to the military, it's problematic to launch commercial cargo. The location of this new commercial launch site should be close to the equator. "South coast of Texas is the lead candidate for that third launch site," Elon said.[408]

To deliver cargo and astronauts to space, SpaceX designed the Dragon capsule. The design of the Dragon is similar to the capsule that carried the

first humans to space. With a white color and eighteen Draco thrusters for control in space, it consists of two main sections. While the upper cone-shaped section, with a flattened top, is pressurized and will return to Earth, the lower cylindrical-shaped section is not pressurized and will not return to Earth.

The Dragon can carry six tonnes of cargo or seven astronauts. The astronauts inside of the cone-shaped section will sit in two rows, with four in the first row and three in the row behind them. In the case of an emergency, eleven astronauts could sit in the Space Shuttle when it returned from space, but seven astronauts was the most common number.

With solar arrays as wings, the Dragon capsule might resemble a flying dragon. But the name originates from the song *Puff the Magic Dragon* by Peter, Paul, and Mary. It was often said the song was a reference to smoking weed, something the authors of the song rejected. But the urban legend lives on. When Elon founded SpaceX, his friends thought he was "puffing" weed to come up with such a crazy idea.[299]

While in space, the Dragon capsule will smell like a fire-breathing dragon. It's difficult to prove, but several astronauts have reported that space has a smell. "Each time, when I repressed the airlock, opened the hatch and welcomed two tired workers inside, a peculiar odor tickled my olfactory senses," an astronaut said. "At first I couldn't quite place it. It must have come from the air ducts that re-pressed the compartment. Then I noticed that this smell was on their suit, helmet, gloves, and tools. It was more pronounced on fabrics than on metal or plastic surfaces. It is hard to describe this smell. The best description I can come up with is metallic; a rather pleasant sweet metallic sensation. It reminded me of my college summers where I labored for many hours with an arc welding torch repairing heavy equipment for a small logging outfit. It reminded me of pleasant sweet smelling welding fumes. That is the smell of space."[293]

The first launch of the Falcon 9 took place in June 2010. "It'll be considered a good day if even the first stage functions correctly. It'll be a great day if both stages function correctly," Elon said.[306] It carried a mock-up of the Dragon capsule, and it was a successful launch. The capsule was put into a 155-mile-high orbit [250 km], where it remained for a year before burning up in the atmosphere while descending back to Earth.

A real version of the Dragon capsule, on the top of a Falcon 9, launched in December 2010. Before the launch, SpaceX announced that the capsule

carried a secret cargo. After the Dragon returned to Earth, landing safely in the Pacific Ocean, SpaceX revealed that the cargo had consisted of a wheel of cheese bolted onto the floor of the capsule.[292]

The cheese was a tribute to the sketch *The Cheese Shop* performed by the British comedian group Monty Python. The idea behind the sketch is that a man walks into a cheese store where he patiently asks what types of cheese the store sells. When the man has gone through all sorts of cheese, it turns out that the store doesn't have any cheese. We now know SpaceX bought the last one. "Don't take yourself too seriously, or you'll start believing your own bullshit," Elon said. So it's clear that Elon has a high respect for comedy, but he dislikes the general celebrity culture. An anonymous celebrity wanted a Roadster for free in exchange for promoting it, but Elon said no.[58,156]

After the second flight of Falcon 9, Elon made a statement. "It proves that we didn't just get lucky the first time around," he said. "Next year we expect four to five launches, the year after that eight to ten, and the launch rate will increase by 100 percent every year for the next four to five years."[50]

To lower the price per launch, all parts of SpaceX's rockets had to be reusable. "The insistence on reusability drives the engineers insane," a SpaceXer said. "We could have had Falcon 1 in orbit two years earlier than we did if Elon had just given up on first stage reusability."[288] But Elon knew the rockets had to be reusable if they at the same time would be cheap. All earlier modes of transportation have been reusable - except for rockets. "Imagine how expensive flying would be if a 747 was a single-flight use," Elon said. "That's a multi-million-dollar aeroplane you'd be throwing away every time. Who could possibly justify such a thing? We'd all be going in boats."[4]

SpaceX designed the first stage of the Falcon 9 to fall back to Earth with parachutes. But in the future all the rocket's stages will land by themselves without parachutes. To fulfill the promise, SpaceX developed the Grasshopper. Like the craft that landed on the Moon, the Grasshopper consists of thrusters and four foldable legs. The thrusters will make each stage land on the ground again in a vertical position. "Design completed for bringing rocket back to launchpad using only thrusters. Yay. Wings r just dead weight in space," Elon said in a Twitter message.

The Grasshopper will increase the turnaround time. Making rockets affordable requires not only reusable rockets, the rockets have to launch again in a short amount of time. A commercial aircraft can fly again in a matter of minutes. The Space Shuttle failed because it was designed to launch again in a matter of days, but in reality it took several months before it could launch again. If the Grasshopper concept works as expected, the first stage of the Falcon 9 will launch again in a matter of hours. It will take more time before the second stage can launch again, so to even out, and since the upper stage is less expensive, SpaceX can manufacture more of those.[315]

A drawback with the Grasshopper is that the payload will decrease. The rocket stages have to preserve fuel so they can land again and the Grasshopper technology increases the weight. But because the rockets can launch more frequently, the system as a whole will be less expensive. “The payload penalty for full and fast reusability versus an expendable version is roughly 40 percent, [but] propellant cost is less than 0.4 percent of the total flight cost. Even taking into account the payload reduction for reusability, the improvement is therefore theoretically over a hundred times,” Elon said.[315]

When SpaceX’s system is fully developed, a pound [0.45 kg] of cargo will cost $100 to launch. “Our performance will increase and our prices will decline over time as is the case with every other technology,” Elon said.[288] The cars from Tesla Motors will become cheaper and cheaper in a similar way as when our computes became cheaper and cheaper, and so will the rockets.

NASA retired the Space Shuttle in 2011 after it had been in service since 1981. They now turned to SpaceX for help to launch cargo to the International Space Station. NASA agreed to pay SpaceX $40 million per launch, which is a price reduction of about 50 to 66 percent. $30 million was the price for a launch with the Pegasus rocket, and $50 million for a launch with the Taurus rocket, but those rockets carried a smaller payload compared with the Falcon 9. It was estimated that the price of the Chinese rocket, the Shenzhou, is $50 million per launch.

Only four entities had flown a spacecraft to the International Space Station: US, Russia, Japan, and the European Space Agency. SpaceX became the fifth when the Dragon docked with the space station in May 2012. “At this point, employees all over the company went bananas,” a SpaceXer said.

When not launching cargo, SpaceX would like to sell trips around the Moon and to the International Space Station.[59] But SpaceX is not primarily a tourist vessel like the Virgin Galactic founded by Richard Branson. Virgin Galactic uses a design based on the same concept that won the Ansari X Prize: a carrier aircraft launches a smaller spacecraft from its belly. “I’ve nothing against tourism; Richard Branson is brilliant at creating a brand, but he’s not a technologist,” Elon said. “What he’s doing is fundamentally about entertainment, and I think it’s cool, but it’s not likely to affect humanity’s future in a significant way. That’s what we’re trying to do. We want to put life on Mars.” Elon, however, bought a ticket on the Virgin Galactic.[58,316]

Before astronauts are allowed to fly with the Dragon, NASA will subject the craft to an intensive review called NPR 8705.2B, short for Human-Rating Requirements for Space Systems. These demands have become more difficult to follow since the last time we traveled to the Moon because our society tolerates only smaller risks. When early rockets blew up, you could hear comments like, “Oh, thank God the monkey wasn’t in that one.” Today it wouldn’t be acceptable to put an astronaut on the top of a converted ICBM originally designed to deliver nuclear weapons. The Space Shuttle was statistically likely to suffer 9 fatal accidents per 1 000 launches, but it changed after the Space Shuttle accident in 2003 to 1 in 1 000.[297]

SpaceX designed the first version of the Dragon capsule to meet 80 percent of NASA’s Human-Rating Requirements simply because they had to if NASA would allow it to deliver cargo to the International Space Station. The capsule was from the beginning equipped with windows. “Technically, if somebody were to stow aboard the cargo version of Dragon, they’d actually be fine,” Elon said. “I mean, hopefully.” What SpaceX needs to add to the design are a launch abort system, seats, and a full life support system. The launch abort system will be designed so the capsule on the top of the rocket can fly away from the rocket if something happens after the launch. Not having one is like a military aircraft without an ejection seat.[297]

The Leaning Factories

“Everyone who tries to reinvent this business believes that auto companies are populated by dummies who don’t understand Moore’s Law,” General Motors said. But compared with a silicon chip, manufacturing a modern car is more complicated. A car has to be of a certain size with parts from across the world, and each customer has chosen their own color and technical details. Except the parts made in-house, Model S consists of 2 000 parts from 200 suppliers. All these parts have to come together at the right place and at the right time – or the factory will stop.[59] This is what SpaceX and Tesla needed as they grew to more complex entities. Elon accepted the challenge. “I think manufacturing is really cool,” he said. “It’s like the ultimate Lego.”[190]

“It’s actually astounding that you can buy a car with all the things a car has for $20 to $30 000,” Elon said. “There’s a whole bag of tricks that the industry has come up with over many decades to make a car super-reliable at a super-low cost.”[325] A description of these tricks is impossible without first telling a short story about how Toyota became the world’s largest car manufacturer.

Toyota is today is a well-known car manufacturer. But in the early 20th century, Toyota was a family loom business called Toyoda Automatic Loom Works. The founder of the company, Sakichi Toyoda, had a son, Kiichiro Toyoda, who was a frail and sickly boy. No one thought he had the physical capacity to become a leader. Sakichi knew he could let his son take over the loom business, but he also knew that cars would be the next big thing. “Everyone should tackle some great project at least once in their life,” Sakichi told his son. “I devoted most of my life to inventing new kinds of looms. Now it is your turn. You should make an effort to complete something that will benefit society.” To learn how to build cars, Kiichiro studied mechanical engineering at the Tokyo Imperial University.[2]

In 1933, Kiichiro founded Toyota Motor Company as a division of Toyoda Automatic Loom Works. The company changed its name from Toyoda to Toyota because they wanted to expand to English speaking

countries. After a competition, they decided to choose Toyota because the name worked better in Japanese and English, and because they thought the eight strokes to write Toyota in Japanese would bring luck and prosperity[406]

After the Second World War, Japan needed to rebuild their bombed cities, so there was a high demand for cars and trucks. But Toyota would still be close to bankruptcy. The high inflation made money worthless and it was difficult to be paid by their customers. To avoid bankruptcy, they cut the salaries with ten percent and 1 600 employees had to retire voluntarily. It saved the company.[2]

In the 1950s, Toyota knew their factory needed to become more productive. After a twelve week long journey through American factories, they saw that Ford's factories were ten times as productive. On the other hand, they also saw that the American factories hadn't changed much since the 1930s when they for the first time visited Ford and General Motors. While the American companies could produce large quantities, the Japanese companies had more limited resources. So Toyota didn't have any other choice than to evolve Henry Ford's mass production system if they wanted to catch up with the Americans. This new production system became known as the Toyota Manufacturing System.[2]

Toyota's factories would now manufacture what they needed at the moment. While visiting factories, they also visited US supermarkets where they could see how a product on a shelf was replaced just after a customer purchased it. Toyota took the idea and adapted it to the factory floor. By delivering the parts needed just-in-time, they could minimize the storage requirements. They implemented *kaizen*, which is Japanese for continuous improvements. The Toyota employees strove always to improve their working methods.[2]

All these new ideas can be summarized with the word evolution. "His [Toyoda] amazing innovation was this: he put in place mechanisms in his company that actively encouraged evolution," Martin Eberhard said. "This was an incredibly bold and risky idea at the time. Toyota has encouraged incremental improvement in every aspect of its business – from the factory floor to vendor relationships to labor relationships to general problem solving in every corner of the company – and today's Lean system is the result of 50 years of encouraged evolution."[367]

Toyota wanted to build the first overseas factory together with an American company. General Motors accepted the invitation because they

wanted to outsource the production of a small car. The factory of choice was a light truck factory in Fremont, California. To show that it was a collaboration between two companies, they renamed the factory to NUMMI [New United Motor Manufacturing].[2]

When NUMMI opened in 1984, General Motors saw how the factory became the most productive of all their factories across the world. The products had a high quality, and the factory was empty – it didn't look like a warehouse anymore. NUMMI became a learning plant for General Motors to which they sent their employees to learn the secrets behind the Toyota Manufacturing System.[2]

The Toyota Manufacturing System spread across the globe to other auto manufacturers, and is often translated with the word Lean. Lately, Lean has spread to other industries such as hospitals, computer programmers, and startups as described in the book *The Lean Startup* by Eric Ries.

As the secrets behind Toyota's high productivity and good quality spread, more factories adopted the ideas and increased their productivity and the quality of their products. This, in combination with economic factors, led to a decision by General Motors to stop producing cars in NUMMI. Toyota decided to stop their production in 2010. The factory that initially brought the ideas from Toyota to America was now empty. But who would need a car factory in California with a value of nearly one billion dollars?

At a rate of 25 per week, Tesla assembled the Roadster in a garage behind the showroom in Menlo Park, San Francisco, and in the Lotus factory in England. But the new Model S would need a large factory. Tesla didn't want to move to Detroit, even though they would have found many empty factories in the area, and they didn't want to move the production to another country.[210] "I think we are seeing a bit of resurgence in US manufacturing and we'll see more of it because things are getting not that cheap in China," Elon said. "I would never build in China, out of intellectual property concerns. It's asking for trouble there. And I'd have to travel to China all the time."[190]

Another option Tesla thought about was to build a new factory in New Mexico. But the then state Governor of California, Arnold Schwarzenegger, opposed the idea. "I wasn't about to let the company that makes the world's

sexiest and best high-performance electric car go to another state, so we left no stone unturned," he said.[337]

Tesla dreamed about how they one day would build cars in NUMMI. "That would be awesome," Elon said. "Maybe at some point we have an opportunity to acquire NUMMI, but that isn't available right now, and we can't afford it really, unless they give it to us."[350]

One day, the NUMMI plant managers received an unexpected call from the president of Toyota, Akio Toyoda, who gave Elon a secret permission to visit the factory. To prevent media attention from spoiling the deal, Toyoda wanted to keep it quiet, so Elon visited the factory incognito. Hoping no one would recognize him, he wore a hard hat, a blue jacket, and plastic safety goggles, and he acted as inconspicuous as possible.[210]

Elon thought the factory would be a perfect match, so Tesla offered what they budgeted for a smaller factory. A month later, Toyota accepted the offer, so Tesla purchased NUMMI in 2010. The price of the factory was $42 million, and $17 million for the machine tools and spare parts.[195] To avoid confusion, the factory was renamed to the Tesla Factory.

On the side of the white factory, the word Tesla was painted with large dark letters. A total of 20 percent of the space will be dedicated to Model S, and 40 to 50 percent of all Model S parts are made in-house. In January 2013, the production in NUMMI reached 400 assembled Model S per week, or 20 000 per year. The rest of the factory is currently empty until more models are ready for production. "The great thing about this place is that it sets us up for the next generation after the Model S. We could have 250 000 cars coming out of here in five years," Elon said.[210,332]

The Tesla Factory's interior is mostly white and gray, including the glossy floor. Because the interior is so large, you have to use bikes to find your way around. The roof features windows so real sunlight can light up the factory. Distinctive from the white interior are the red industrial robots performing various tasks around the factory, including welding different parts together, moving unfinished cars around the factory, and installing the seats. What the robots can't do, the humans have to do while listening to tunes like *Sweet Child O' Mine* by Guns N' Roses.[51] "I think it's important to have an environment where people look forward to coming to work," Elon said. "It's worth putting some effort into making the factory beautiful."[332]

Someone who would be envious of Tesla's new factory was Steve Jobs. When he wanted to paint his factory white, Jobs got comments like, "You can't paint a factory pure white. There's going to be dust and stuff all over." But Jobs, who had visited the Japanese factories that applied the Toyota Manufacturing System, knew his factory could be clean. "I'd go out to the factory and I'd put on a white glove to check for dust," Jobs said. "I'd find it everywhere – on machines, on the tops of the racks, on the floor. And I'd ask Debi to get it cleaned. I told her I thought we should be able to eat off the floor of the factory. Well, this drove Debi up the wall. She didn't understand why. And I couldn't articulate it back then. See, I'd been very influenced by what I'd seen in Japan. Part of what I greatly admired there – and part of what we were lacking in our factory – was a sense of teamwork and discipline. If we didn't have the discipline to keep that place spotless, then we weren't going to have the discipline to keep all these machines running."[3]

Because of Elon's background in the space industry, he knew a factory could be clean. In the space industry, you have clean rooms where you can't even have dust particles in the air. "From an environmental standpoint, we want this to be a shiny example of what an automotive plant could be," Elon said. "You will literally be able to eat from the floor of the factory. It will be the cleanest place you've ever seen."[438]

There's a story about a factory that wasn't spotless. This factory was filled with so many items that they lost a prototype car stored in the factory. The prototype car remained hidden for weeks. No one knew where it was, until they found it buried between the waste.[2]

Elon thought you can only judge a car's beauty if it's framed by beautiful surroundings, so the final inspection area in the factory got a wooden floor.[332] "Before delivery, the car must go through quality testing," the VP of manufacturing, Gilbert Passin, said. "Typical quality tests consist of a rolling road [a device that mimics driving on real streets], a water test to check for leaks, and an inspection station that ensures all components are installed to standard. Instead of wasting gallons of water to perform the leak test, we will instead employ ultrasonic waves inside the car as a device on the exterior detects escaping waves."[249]

Both SpaceX and Tesla have the same policy as several companies in the computer industry, but these policies are often not common within the space- or auto industry. Food and snacks are available for free, they can find free M&M, Beef Jerky, and Starbursts. They are, however, not encouraged to

feed the snacks to their pets they are allowed to bring with them. If they need a break, they can visit the arcade room with pinball machines. “You keep your engineers happy and they work a little longer and harder,” Elon said. “It’s counter-intuitive, but it works.”[4]

Tesla applied the ideas behind Lean by minimizing the number of parts stored in the factory. But one day the assembly line stopped. A container from China was stuck in customs, so they didn’t get the supply of a $3 USB cable needed for each car. It’s common to have a reserve plan if something like this happens, and it consisted of flying in the cables from China. But it failed because Tesla’s credit limit was exceeded. To solve the problem, Tesla had to send employees to stores around the factory to hunt USB cables.[353] Another shipment of trunk carpets from a supplier in Mexico was delayed because of a drug shootout close to the border. Until the shipment arrived, Tesla had to store unfinished Model S on the parking lot.[392] This is the drawback when your factory is Lean. You may save money if you minimize the inventory, but you may lose money if you can’t fly in any parts because a volcano on Iceland disrupts the air traffic. “It’s unbelievable how painful it is when you are missing one thing and the whole machine grinds to a halt,” JB Straubel said.[426]

Another idea Tesla got from Toyota was to combine engineering and production by having both types of engineers close to each other. The Toyota Production System calls this *genchi genbutsu*, which can be translated to “going to the place to see the actual situation for understanding.”[2] “When you try to make something there’s a big leap between making that first prototype and actually making it, manufacturing it in large quantity with good quality,” Elon said. “And for some reason people decide, ‘oh, they’re gonna do the engineering here and do the manufacturing on the other side of the world.’ And I think that actually ends up being inefficient. I like that combination of engineering and manufacturing.”[354] The design engineers responsible for the construction of the product need to visit the factory to see the mistakes they’ve made, and the production engineers can suggest improvements to the design engineers. This process is more efficient if both the factory and the research & development office are close together.[361]

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1 Rocket Road, Hawthorne, is in the part of California famous for the home of Brian, Carl, and Dennis Wilson of the Beach Boys. Their music

flowed out of the hot rods and sports cars at the Hawthorne Boulevard – one of the world's most well known cruising spots. The cruisers told their parents they were going to the Hawthorne city library, only a block from the cruising spot, but they just met at the library so they could cruise Hawthorne Boulevard. When their parents discovered the lie, they took the car keys, hence the "Fun fun fun til her daddy takes the t-bird away" in the Beach Boys song *Fun, Fun, Fun*.

Before Hawthorne drowned in engine sound and music, you could hear military airplanes takeoff from the Jack Northrop Field. During the Second World War, Jack Northrop founded Northrop Aircraft Corporation, and they flew airplanes, like the P-61 Black Widow, from the airfield adjacent to 1 Rocket Road. At the address, you can today find a large factory ordered by Northrop in 1966 in which parts for the Boeing 747 were manufactured.

The surroundings may be welcoming, but almost no one is, for 1 Rocket Road belongs to SpaceX. The security around the area is high to avoid industrial espionage. SpaceX has a policy not to apply for patents, simply because they believe a competitor will copy these patents. "Our primary long-term competition is in China," Elon said. "If we published patents, it would be farcical, because the Chinese would just use them as a recipe book."[305]

Before SpaceX moved to 1 Rocket Road, they looked at Howard Hughes's old compound in Playa Vista. Famous from the movie *The Aviator*, Hughes had a vision as large as Elon's when he designed a giant aircraft made entirely of wood. "It will invite comparisons. I better not pee in a jar or grow my fingernails long," Elon said. He didn't want to be compared with Hughes, who displayed signs of mental illness when he became obsessed with the size of peas and sorted them by size with a special fork.[301]

The entire US space industry involves almost 500 000 people across 50 states. In comparison, the entire SpaceX is in one building – except for the tasks that must be performed in a more remote place. Steve Jobs thought the right kind of building could do great things for a culture. If everyone works in the same building, the creativity will increase. "There's a temptation in our networked age to think that ideas can be developed by e-mail and iChat," Jobs said. "That's crazy. Creativity comes from spontaneous meetings, from random discussions. You run into someone, you ask what they're doing, you say 'Wow,' and soon you're cooking up all sorts of ideas."[3]

To make the environment as creative as possible, 1 Rocket Road had to be completely renovated. Elon himself picked the colors, the furniture, the

spaceship-looking trashcans, and the toilets. “I was looking for creative urinals. It’s a nice pot,” Elon said.[54] The factory became so futuristic that a couple of scenes from a movie were filmed inside of it.

Elon enjoyed watching the movies *Chicago* and *Lord of the Rings: The Two Towers*.[307] But he doesn’t like movies that rely on character stupidity in order to advance an already implausible plot. “They come across a downed moose that obviously wasn’t killed by a bear and then one woman finds bloody claw marks in the stone wall because some kind of creature was so desperate to escape something chasing it and she doesn’t even say, ‘Hey, look at this, this is weird?’” Elon said about a bad movie he saw. “Didn’t anybody in the group go down into that cave with a bad, bad feeling? It’s like I can see right through the story, it’s like I can see right around behind it to this idiot who’s sitting at the typewriter inflicting this crap on me in the first place.”[162,170]

One morning, Elon read a strange e-mail. “Will you read this for me,” Elon asked Justine. “I’m not misreading it, right? That is the actor?” she asked. In the e-mail, the star of the movie *Iron Man*, Robert Downey Jr, asked if he could visit Elon as part of his research to learn how to live and act like an engineering genius.[155] “When I was trying to bring the character of genius billionaire Tony Stark to the big screen in Iron Man, I had no idea how to make him seem real,” the producer and director of the movie, Jon Favreau, said. “Robert Downey Jr said, ‘We need to sit down with Elon Musk.’ Downey was right. Elon is a paragon of enthusiasm, good humor and curiosity – a Renaissance man in an era that needs them.”[416]

Elon accepted the request and the actor took the chance to participate in a real meeting between SpaceX and NASA engineers. “Was that actually Robert Downey Jr and why was he at that meeting?” one engineer asked Elon. To return the favor, Tony Stark’s garage in the movie included a Roadster, and Elon and his wife were invited to the movie set. “I think he said that he was a lifelong fan of comics in general and Iron Man in particular,” Justine said of Downey Jr. “This movie is pretty special to him – the light in his eyes was like a kid’s.”[150]

In the sequel, *Iron Man 2*, Elon had a small role in the movie as himself where he, while wearing a white suit, talked rocket engines and electric airplanes with Tony Stark. “Mr Musk,” Stark’s secretary, Pepper Potts, said before the conversation began. In the movie, you can also see a couple of scenes filmed inside of the SpaceX factory.

Standing in the entrance to the factory, there's a life-size statue of Tony Stark in his Iron Man suit. The movie crew signed it. You can also find a large robot from the television series *Battlestar Galactica* and the now famous cheese that traveled to space and back.

The factory includes office space, manufacturing, and several special rooms. There's a room with a climate control. You need to have a constant temperature to measure something with high accuracy because materials expands and contracts as the temperature changes. To test if the different parts of the rocket can survive a launch, there's a shaker room simulating a real rocket launch. In the factory, you can also find the mission control room that looks like a classroom with rows of desks after each other. In the movies, the mission control room is usually sloped, but at SpaceX the room is flat. The office space is open to maximize the communication between employees. Each employee has a quite large cubicle with low walls. Elon himself has his office in this open office space. At other companies, it's more common that thick walls surround the office of the CEO.[333]

To decrease the price of the rockets, SpaceX manufacture about 80 percent of the parts in the factory. The main reason to why rockets are so expensive is the high cost culture in the space industry. "There's this tendency of big aerospace companies to outsource everything," Elon said. "They outsource to subcontractors, and then the subcontractors outsource to sub-subcontractors, and so on. You have to go four or five layers down to find somebody actually doing something useful – actually cutting metal, shaping atoms. Basically, things take a long time and costs a lot if you buy it from an airspace supplier. Things are cheap and readily available if you buy it from an industrial supplier. The whole airspace industry have gotten used to that situation and we [SpaceX] need to get them not used to that situation."[305]

SpaceX needed to purchase an engine valve. The supplier explained how it would take more than one year and thousands of dollars to develop the valve. SpaceX told them it was too expensive and it would take too long time. "Good luck with that," the supplier replied, smiled, and left the building. SpaceX set out to develop the valve themselves, and it was ready when they needed it. The smiling supplier called back and said they were now willing to make the valve. SpaceX replied that they had already made it themselves. "There was just silence at the end of the line," Tom Mueller said. "They were in shock. That scenario has been repeated to the point where we passionately avoid space vendors."[288]

Another supplier of parts to the rocket's fuel tanks raised the price after delivering only a small amount of their products. They thought SpaceX didn't have any other choice than to accept the higher price. The supplier was wrong and is no longer a supplier to SpaceX. "It was like a painter who paints half your house for one price, then wants three times that for the rest," a SpaceXer said. "That didn't make Elon too enthusiastic. He was like, 'All right, we're not going to get screwed by these guys.'"[278]

While Tesla named each conference room after failed electric car companies, SpaceX named each conference room after scientists, engineers, and astronauts related to the space industry.[453] But Elon is generally not a fan of meetings. "Meetings are what happens when people aren't working," he said.

A conference room was named after the German Hermann Oberth, who is considered one of the founding fathers of rocketry and astronautics. Another founding father is the Russian Konstantin Tsiolkovsky, who also gave his name to a conference room.

Another conference room was named after the American Robert H. Goddard. He became an early American space pioneer and is considered a founding father of rocketry and astronautics. In an article from 1919, Goddard explained how a rocket could travel in the vacuum of space to the Moon. No one believed him. To prove his theories, Goddard attached a pistol to a spindle free to rotate inside a bell jar from which the air was evacuated. When Goddard fired a blank cartridge, the gun recoiled in the direction opposite to the escaping gases, and it proved that his theories were correct. In 1926, Goddard launched the first rocket propelled with liquid oxygen and gasoline. The rocket traveled to a height of 41 feet [13 m] and landed 184 feet [56 m] away in a cabbage patch. His team's later rockets reached heights of 1.6 miles [2.6 km].[132]

A fourth conference room was named after Wernher von Braun, and there's a portrait of him hanging in the entrance to the SpaceX factory. The German rocket engineer became interested in space when his mother gave him a telescope. At school, von Braun found the book *Die Raketen zu den Planetenraumen* [The Rocket into Planetary Space] by Hermann Oberth. "Its pages were a hash of mathematical formulas," von Braun said. "It was gibberish. I rushed to my teachers. 'How can I understand what this man is saying?' I demanded. They told me to study mathematics and physics, my two worst courses." When he realized that both mathematics and physics

were important, he excelled in both subjects. With a degree in mechanical engineering, he began a secret doctoral dissertation for the German army.[131]

During the Second World War, von Braun directed the development of the Aggregate series of rockets. If the war had not ended, the rockets would have ranged from A-1 to A-12, where the A-12 was designed to carry a 10 tonnes payload to low Earth orbit. The A-4 rocket was the first man-made object to reach space. But the Germans realized they could use the A-4 as a weapon. The well-known, notorious V2 rocket was born.

The V in V2 stands for *Vergeltungswaffe* [Retaliation weapon]. The first in the series was the V1 – a small, unmanned aircraft powered by a pulse-jet engine. Launched against England, the V1 was slow and thus easy to shoot down by British fighter pilots. The same fighter pilots realized that the V2 was impossible to intercept and destroy because it traveled at supersonic speeds. The first V2 crashed in west London in September 1944, killing three people and injuring seventeen. More than 3 000 of these rockets were fired against London and other targets during the end of the war.[130]

The German rocket technology was at least 25 years ahead of everyone else. US noticed that the Soviets were interested in these rockets, so to not get behind, they decided to capture as much rocket technology as possible. And since no one knew if the nuclear bomb would work, the V2 could be useful in the war against Japan, which at the time seemed far from over. Before the war in Europe ended, both American and Soviet troops tried to capture von Braun himself, his engineers, and his technology.[36]

Soviet forces were the first to reach the German rocket center in Peenemünde. But it was empty. During the last months of the war, horror stories spread among German troops and civilians about what would happen to them if the Red Army captured them. To avoid this faith, they retreated west to be captured by mainly American and British forces. Von Braun was ordered to stay and fight. But he ignored the order and retreated west together with rockets, engineers, and documents containing his research. He would eventually be captured by American troops.[36]

US initiated Operation Overcast – a program to acquire German technology and expertise. The decision to recruit German expertise was under many discussions, and the original plan was to intern them at a distant island. Von Braun was ranked as one of the scientists most adaptable to the American lifestyle, thus he, together with 350 German specialists, emigrated to the US.[131]

Von Braun began working on the nuclear missile program that would eventually turn into a space program. As the Russians worked on their own nuclear missile, the race to build the largest rocket had begun. Both teams began with the basic V2 rocket. The two countries had competed in who could transport most rocket technology away from Germany. 92 trains headed for the Soviet Union, while the US took rockets and 14 tonnes of documents. The Soviets, however, didn't find any blueprints. To draw new blueprints, they captured German engineers, deported them, and forced them to reproduce all the blueprints for the V2. It took two years.[36]

Compared with his competitors across the globe, von Braun lived a better life in US, but would always be remembered of his German origin. He claimed that he wasn't a Nazi and he had only joined the Nazi Party to be able to work on his rockets since civilian rocket tests were outlawed. "We felt no moral scruples about the possible use of our brainchild," von Braun said. "We were interested solely in exploring outer space." But it has been estimated that 7 000 people died in V2 attacks, and 12 000 slave laborers died while building the rockets.[131]

During one press conference, a journalist asked jokingly if von Braun's new American rocket would land in London – a reference to the V2 rockets landing in London during the war. It made von Braun leave the room. Another common way to taunt von Braun was to talk about NASAism, a word similar to Nazism, and the satirist Tom Lehrer sang, "Once the rockets are up, who cares where they come down? 'That's not my department,' says Wernher von Braun."[15]

The US rocket engineers lost against the Soviet Union in the race who could launch the first satellite. Von Braun was ready to launch a satellite on the top of his modified Jupiter-C rocket called Juno-1. But he wasn't allowed to, mainly because of political reasons as he was from Germany. To prevent von Braun from launching a satellite by "accident," Pentagon sent inspectors to monitor the first successful launch of the rocket in September 1957. The rocket made by American engineers failed, and the Soviet Union launched the R-7 rocket carrying the satellite Sputnik in October 1957. Von Braun was finally allowed to launch the Juno-1 carrying the satellite Explorer 1 in January 1958.[36] The German engineers were now trusted, so von Braun could begin designing the Saturn V rocket.

When you are working at SpaceX and hear the word von Braun, you are not always hearing it because someone is talking about the room or the man.

You might hear it because someone is talking about a conflict that requires an immediate solution. One NASA manager who visited SpaceX said that when there's a new problem to solve, it looks like a flash mob in the hallway.[288] This is how a discussion can sound:

> "Would you VPPA? [variable polarity plasma arc – a welding method]."
> "Naaaaaah, I'd probably go to soft plasma [another welding method]."
> "You always get misplaced diameters with that."
> "What if the heat shield attached to the Dragon's base…"
> (A slight pause)
> "We'll take it to the von Braun!"[49]

A Burning Man

Maye Musk's twin sister, Kaye Haldeman, found a husband in South Africa and changed her surname to Rive after their marriage. They had four children: Russel, Peter, Lyndon, and Almeda. The siblings grew up in Pretoria in a house close to Nelson Mandela's home.

After Mandela passed away in 2013, Lyndon recalled that Mandela was one of his greatest role models. "With time, people can overcome their own prejudices," he said. "With dedication, progress can happen, even if it takes decades. It is possible to fight hard for change while also seeing the humanity in your opponents. Mandela kept his dignity through decades of inhumane treatment, and never let the way he was treated affect the way he treated others."[427]

During Lyndon's final year in high school, he began selling cosmetics while learning everything about marketing, sales, and logistics. This knowledge would in the future be helpful. He was also a swimmer for South Africa's national underwater hockey team.[102] "It's a sport that you play underwater, mask, fins, one-handed stick, and lead puck," Lyndon said. "On the bottom of the pool, go down, hold your breath. Before you run out of air, you give the puck to your buddy and go up for air."[237]

After Elon and his brother Kimbal founded Zip2, they recruited their cousin Russel to work with them. Peter studied at the same university as Elon had studied at: Queen's University in Canada. He was also an ultimate frisbee player. It's a relative unknown sport similar to rugby, but you are not allowed to run with the frisbee.[102]

In 1998, and with their cousin Elon as an investor, Lyndon and Russel founded the data-center software company Everdream.[51] Their customers included companies like FedEx, UPS, and a number of airliners. Everdream was the same company that helped Elon to save his empire when his cousins sold it.

Elon expects the same results from his cousins and treats them in the same way as he would treat everyone else. Lyndon, who already drove a Tesla Roadster, wanted to buy a Model S. He asked Elon if he could skip the

waiting list. Elon told Lyndon to visit the website and order one like everyone else. Lyndon had to wait for Model S number 808.[109]

By 2004, Everdream was, after some troublesome years, on the right track, so Lyndon teamed up with Peter and they began to wonder what they would do next. The same year, they attended Burning Man together with Elon.[102]

Beginning on the last Monday in August and ending on the first Monday in September, Burning Man is a weeklong festival. The festival is not like one of those music festivals – it's more of an experiment in community, art, radical self-expression, and radical self-reliance. "The great difference between us and the consumer marketplace, however, is that we have inverted the essential nature of the capitalist system," the founder of the festival, Larry Harvey, said. "We may be like Disneyland, but we are like Disneyland turned inside out. Because at the heart and center of this thing you will not find a commodity to be consumed."[100]

One night in 1986, at Baker Beach in San Francisco, Harvey torched an eight feet [2.4 m] high wooden stick figure in front of only a few people. Four years later, the number of visitors had grown so much the festival had to move to the Black Rock Desert in Nevada. The tradition to burn a wooden figure continued, thus the name of the festival.[110] Because of the ever growing interest – 120 000 people wanted to buy tickets to the 2012 edition of the festival – the number of participants had to be limited to around 50 000.

The festival's camp is called Black Rock City and looks like a half-eaten donut if you fly over the area. The donut itself is divided into two main parts: one quieter and one louder. Cellphones used to be banned from the camp, but it's today acceptable to use them as long as the call is not made in a public space.

No soft sand dunes can be found in the Black Rock Desert, so the ground is drivable. The British ThrustSSC jet-propelled car set the world speed record on land in the same desert. Equipped with two engines from the F-4 Phantom II jet fighter, the car rushed through the desert with a top speed of 763 mph [1228 km/h]. Before Burning Man begins, but with a slower speed than the ThrustSSC, several of the visitors drive through the desert in their own special mutant vehicles and art cars. These vehicles look like something from an art exhibition. But they are not always driving, one team sailed through the desert in a wind wagon.

The story behind the wind wagon began in 1853. Before the railroad through the American wilderness was finished, Thomas Smith had an idea to replace the slow horse-drawn wagons that transported people and freight. His idea consisted of wind-powered wagons that would sail across the continent. Smith began by constructing a smaller prototype and proved it was possible to sail to a town 300 miles [480 km] away.[99]

Smith was now ready to construct a larger prototype and he invited the company's investors to the maiden trip. The brisk wind on the day blew the wind wagon to speeds of 22 mph [35 km/h]. The ball bearing and the shock absorber had not yet been invented, so while smoke appeared from the wheels, the wagon began to shake until the steering mechanism failed. The scared passengers lost faith in their investment and escaped from the wagon, breaking arms and legs. Like the captain of *Titanic*, Edward Smith, his precursor remained on his wind wagon until the end when it finally broke down. He had to limp home.[99]

The modern version of the wind wagon didn't break down. "It's a boyhood dream building something that has never existed," one of the creators said. "I want to honor those who tried what no one else has tried or like no one else has thought. It is only the most insane and most dedicated who go out with their big crazy ships."[101]

Elon has attended Burning Man at least nine times. With him, he brought his electric rocket art car and he has also attended the festival dressed like Darth Vader from the *Star Wars* movies.[358] To have somewhere to live, he rented eight recreational vehicles with trailers and staff.[110]

During the five-hour drive to the festival, Elon and his cousins began to discuss how they could change the world. Maybe Elon talked about how he would power his electric cars without fossil fuels. He had earlier tried to buy solar panels for his mansion in Bel Air, but realized it was impossible to find a good supplier. "These were very, very mom and pop shops," Elon said. "There was no organization I could turn to, to get good installation, professionally done, and feel they would still be around in a few years. None of them have put any serious effort into honing the whole process – you know, squeezing out excess parts and labor – and then they have no economies of scale as far as buying panels en masse or establishing best practices."[71,104]

When Elon and his cousins arrived to the festival, Peter and Lyndon were convinced to start a company within the solar power industry. "I

thought that it was an area that needed people like them [his cousins], who are really good entrepreneurs, because solar wasn't doing well as an industry," Elon said.[104]

Our attempts to harness the Sun has a long history. More than 2000 years ago, it was said that the Greek scientist, Archimedes of Syracuse, had invented a powerful weapon. He used the reflective properties of bronze shields to focus sunlight to set fire to wooden ships from the Roman Empire during the Siege of Syracuse. No proof of the weapon exists today, but the Greek navy recreated the experiment in 1973. From a distance of 164 feet [50 m] they managed to set fire to a wooden boat.[422]

In the 19th century, the industrial world was dependent on mainly coal as a power source. As coal is a finite resource, scientists and engineers became concerned that the industrial world was running out of coal. The French mathematician, August Mouchet, attacked the problem by designing solar-powered steam engines.[422] "The time will arrive when the industry of Europe will cease to find those natural resources, so necessary for it," Mouchet said. "Petroleum springs and coal mines are not inexhaustible but are rapidly diminishing in many places. Will man, then, return to the power of water and wind? Or will he emigrate where the most powerful source of heat sends its rays to all? History will show what will come."[423]

A 19 year old Alexandre-Edmond Becquerel showed in 1839 how to convert light from the Sun to electricity – the photovoltaic effect. But as more oil was found and the solar technology was still expensive and inefficient, the world continued to be dependent on fossil fuels.[422]

According to Elon, solar power will in the future be a major part of the technologies used to produce the world's energy. The rest of the energy will come from a combination of nuclear, wind, hydroelectric, and geothermal power. "I think that solar power will be the single biggest source of electricity, at least in the US," Elon said. "If you look at the growth rate of solar then we will have power as long as the Sun shines. And if the Sun doesn't shine, we have larger issues. Actually, the Earth is almost entirely solar powered today. The only reason to why we are not a frozen ice ball is because of the Sun. So it's really about taking a little bit of that solar power and turning it into electricity that people could use."[357]

The number of solar panels we need if we are going to replace our dependency on more risky power sources is not as large as you may first think. Around a nuclear power plant, there's a large zone where you are not allowed to walk. Elon argued that if we covered these zones with solar panels, then the energy produced from these panels would be larger than the energy produced by the nuclear power plants themselves.[339]

The US President Jimmy Carter had the same ideas as Elon when he installed solar panels on the top of the White House during the 1973 energy crisis. "It can be a small part of one of the greatest and most exciting adventures ever undertaken by the American people; harnessing the power of the Sun to enrich our lives as we move away from our crippling dependence on foreign oil," Carter said.[43]

Elon and his cousins set out to reinvent the solar industry. But there was one problem. Lyndon lost his visa status and was about to be forced out of the country. "Because I didn't have a degree, I couldn't get a green card," Lyndon said. While in high school, he met his wife, and he introduced her to underwater hockey. Because his wife was considered a specialist in underwater hockey, she got a so-called green card. Since Lyndon married her, he also got a green card, and both of them could remain in the US. They are still practicing the sport for the US team.[108] "But I wasn't able to stay in the country for employing 280 people and eventually selling the company [Everdream] to Dell Computers," Lyndon said.[237]

Elon became a US citizen ten years after immigrating to the country. Together with 3 500 other immigrants, he took the oath of American citizenship at the Pomona Fairplex. The ceremony was according to Elon "actually very moving."[278] His wife Justine slept through the alarm clock and missed the ceremony to get her American citizenship. Filled with anxiety, she realized she could attend a later ceremony.[142]

With the citizenships secured, Peter and Lyndon began to learn everything about the solar power market in the same way as their cousin Elon would do it: read books and learn by doing. In 2005, they visited the exhibition Solar Power International. Of about 1 000 attendees, everyone they met worked with the development of solar panels and how to manufacture them. "The barrier to getting individuals to use solar power was the up-front cost of installing the panels," Lyndon said. "No one was talking

about barriers to purchasing and delivery problems. If no one was focused on the end market, this business would make no progress."[60,102]

Manufacturing a standardized solar panel is not difficult. "Making standard efficiency solar panels is about as hard as making dry wall," Elon said. "It's really easy. In fact, I'd say dry wall's probably harder."[363] The large problem would be to convince the society to install solar panels on thousands of rooftops. "You know, most of the taint is around solar manufacturing," Lyndon said. "Our business model is totally different." The siblings had realized that they didn't need to manufacture any solar panels. They would just buy the parts and install them.[237]

In a kitchen, Peter, Lyndon, and Elon founded SolarCity in July 2006. Their vision was to create the most compelling energy company of the 21st century by delivering cleaner, cheaper power through distributed generation. Lyndon became the CEO of the company, and Peter the COO as well as the CTO. SolarCity recruited their sister Almeda for work with sales. The fourth sibling, Russel, didn't join them. He lived in Brazil where he married and owned the interactive-graphics firm SuperUber.[102] Elon visited him in Brazil. "It was the worst place I've stayed since I was a teenager," he said. "It stank, there were stains on the sheet, and the bedbugs did bite. It was awesome. We had a good time."[54]

His cousins would do the hard work, but Elon told them he would provide money and guidance. They calculated that they needed $10 million to begin the company's hiring, marketing, research, and development efforts. "It is a fairly large round to show the company is serious about entering this market and has enough capital to move quickly," Elon said.[104]

While several companies are building large solar power plants with thousands of panels in the desert, SolarCity will spread out their panels on the roofs of homes and office buildings. All these buildings will together form a gigantic power plant. "We're an energy company," Lyndon said. "We install solar systems for free, and we sell the electricity at a lower rate than you can buy it from the utility. So given the option of paying more for dirty power or paying less for clean power, what would you take?"[237]

To convince thousands of customers, SolarCity needed to make it as easy as possible for them to install the panels by providing the sales, financing, engineering, installation, and monitoring. The only thing the customer had to do was to let SolarCity into the house where the panels

would be installed for free. With the solar panels installed, the customer had to pay a sum each month to lease them. No regular maintenance was needed, the only work someone with solar panels on the roof needed to do was to trim their trees to avoid shading of the panels.[397]

In the future, the excess electricity produced by the solar panels will most likely be stored in batteries inside of the house. “We think in the years ahead this will be the default way that solar is installed,” Peter said. “Getting the costs down, though, is not going to be an easy task.”[103] His cousin Elon had the same idea. “Future will indeed be rooftop solar + battery pack, w [with] utility company just providing backup power,” Elon wrote in a Twitter message.

SolarCity together with Tesla Motors solved one of Elon’s three things that in the future will most affect the future of humanity: the transition to a sustainable energy economy. “To get to a sustainable energy future, we must have both sustainable energy creation and consumption,” Elon said. “So SolarCity is about sustainable energy creation, whereas Tesla is about sustainable energy consumption.”[327]

The electric vehicles could now be powered with solar panels. Not a single drop of oil or a single brick of coal would be needed anymore. “With just a small 10 feet by 15 feet [3 m by 4.5 m] solar panel tucked away on the roof of your garage, you will generate enough electricity to travel about 400 miles [640 km] per week in the Tesla Roadster,” Elon said. “If you travel less than that, you will be energy positive with respect to transportation and the excess electricity will offset your home’s power usage.”[248]

There have been suggestions that you can increase the range of an electric vehicle by installing solar panels on the vehicle itself. But it sounds better than it is. “That’s a little bit like fins on a Cadillac, they are decorative and it looks nice, but they don’t do very much,” Martin Eberhard said. “The amount of energy that hits the roof of your car isn’t enough to make a big difference. If you’ve got pretty good solar panels and cover the whole top surface it might increase the driving range by 10 miles [16 km]. Far better is to leave your solar panels at home where they can be at a perfect angle and they can store that energy in the perfect storage system called the grid.”[355]

One of the first owners of the EV1 electric car from General Motors was Kris Trexler. You could only lease the EV1 in California and Arizona, so

Trexler came up with an idea to market the EV1 to the rest of the country. He made a 3 275 miles [5 270 km] long journey called Charge Across America. “Thanks to the Walmart in Redlands, I charged the batteries up to 96 percent full using their free public charging station,” Trexler said. “I found another red EV1 parked in an adjacent charging space. Good company. Infrastructure is essential to the success of electric cars. Imagine gasoline powered cars with no gas stations.” The problem with this trip from Los Angeles to Detroit was that it took three weeks. When Trexler arrived to Detroit, he flew home while the car was shipped by truck back to Los Angeles.[211]

Luckily, the electric car technology has improved since the days of the EV1. In September 2012, Tesla revealed that SolarCity would supply solar panels to Tesla’s own network of charging stations called Superchargers. These stations are similar to a traditional gas station, but for electric vehicles only. Because the stations will supply more energy than what will be used by the electric cars, the vision is that they will be like small power plants that supply electricity to the area around them.

The Supercharger network became the solution to the three problems that held back electric vehicles in favor of gasoline vehicles.

The first problem was that the driver of an electric vehicle should be able to drive long distances with the same ease as if the driver had a gasoline car. Tesla optimized the distance between the Superchargers so the drive-break cycle will be the same as if it was a gasoline car. Sooner or later, any driver has to take a break for 30 minutes. While taking this break, the driver can charge the electric vehicle. “We looked at the major population centers and said ‘Well, people don’t just drive at random across the whole area – they follow the main routes and corridors,’” JB Straubel said. “You can look at how many stations [Superchargers] you need and that’s a very small number. It’s not tens of thousands; it’s actually a few hundred stations if they are exactly in the right places between cities.”[426]

The second problem was that the electric vehicle should be charged with clean energy. Charging with energy from a coal power plant is cleaner compared with using a gasoline car, but charging with clean energy is the best option.

The third problem was that an owner of an electric vehicle should be able to charge the batteries cheaper compared with filling the tank in a gasoline car. Tesla promised it would be free to charge Tesla cars at these stations. “We always want it to be the case that the Supercharger is free once

you've bought the car," Elon said. "So we don't want to have this kind of pay every time you arrive thing. I think it's just so much easier for you to just build it into the cost and you arrive and you just never have to deal with anything."[250]

In the history of Tesla, the Supercharger network became an important milestone. Elon thought it was a similar milestone as when SpaceX for the first time docked with the International Space Station. "Tesla's Supercharger network is a game changer for electric vehicles, providing long distance travel that has a level of convenience equivalent to gasoline cars for all practical purposes," Elon said. "However, by making electric long distance travel at no cost, an impossibility for gasoline cars, Tesla is demonstrating just how fundamentally better electric transport can be."[387]

It still takes longer time to charge a Tesla with electricity from a Supercharger compared with the time it takes to fill up the tank in a gasoline car. To tackle this problem, the engineers designed Model S's battery in a way that the battery can be replaced with a charged battery. "You'll head to a battery-swap station, drive your car onto rails that lock your car into position like at a car wash, and a customized forklift device will grab the pack from beneath the car, pull it out, and replace it with another pack," Elon said. "It'll take roughly five minutes – less time than filling your gas tank."[373]

Critics argued that installing Superchargers across the country would not be enough. Many car owners are living in apartments and can't charge their vehicles in a garage. In a survey, 43 percent said they didn't have the ability to charge an electric vehicle in home or at work.[388] To build a complete network of charging stations, it was estimated that it will cost hundreds of billions.[59] But the number of charging stations today can be compared with the number of gas stations when the gasoline car was new. Today there are 119 000 gas stations in the US that didn't exist 100 years ago – and it was certainly not free to build them.[424]

When there was a demand for gas stations, it didn't take a long time to build thousands of them. The first public gas stations were called filling stations and they began to appear in 1907. Car owners had earlier purchased gasoline in shops that handled the gas as a sideline to other business activities. By 1920, the filling station was often a small building with gas pumps in front. They offered supplies like tires, batteries, and oil, and simple services like lube jobs and tire patching. As the number of gasoline cars

grew, so did the number of gas stations. In 1920, US had 15 000 gas stations, and by 1930, the number of gas stations had grown to 100 000.[424]

Elon established the Musk Foundation in 2001. The homepage doesn't reveal much, the only text available is: "Grants are made in support of: Renewable energy research and advocacy, Human space exploration research and advocacy, Pediatric research, Science and engineering education." It's unclear why he established the foundation, but another event happened the same year that may have influenced the decision.

Elon's mother Maye Musk worked as a dietician and became fluent in six languages. She also worked as a model.[4] At age 63, she appeared naked and pregnant on the cover of the *New York Magazine*. "Is she just too old for this?" the headline next to the picture asked. But the picture was fake – she wasn't naked nor pregnant at the time of the photograph. The actress Demi Moore appeared in a similar picture on the cover of *Vanity Fair*, and the magazine with Maye on the front page included a story about what age is too old to give birth.[76]

In 2001, Maye lived in New York, and so did Elon's brother Kimbal, who had moved there after Zip2 was sold. One day in September, Justine woke up when she heard Elon yelling in the phone. "No shit," he shouted. "You're kidding me. You're fucking kidding me." He went down to his computer and checked the news. "Wake up," he shouted to Justine. "You have to wake up. The World Trade Tower's on fire. It's on fire." Elon was worried since both his brother and mother lived in New York. Kimbal lived only a few blocks away from the burning buildings.[161]

"I was blocks away when the towers fell, and you just can't imagine what it was like to see the pile of melted metal," Kimbal said. He had together with his girlfriend early decided to retreat to their friend's apartment. Kimbal stepped up as a volunteer. "I helped feed the firefighters for six weeks. I was a recent graduate of the French Culinary Institute and they had me peeling potatoes for a week," Kimbal said.[87]

An earthquake devastated the island of Haiti in 2010. To help the poor country, the head of the Artists for Peace and Justice, Bryn Mooser, decided that the organization should build a school and start a baseball team. With him, he wanted to bring Elon to see if he could apply some of his knowledge

to help the country. “I want inventors to go down to Haiti. I want geniuses to go down to Haiti,” Mooser said.

“I’ll take you any day you want to go,” he told Elon. “Literally, any day. You’re a hero.”

“How about Christmas Day?” Elon answered.[120]

They traveled to a remote village in Haiti far out in the countryside. With the help of Elon’s private jet, they brought 450 toys and 35 MacBook Air laptops. At the Christmas party barbecue, Elon showed the children how to build and light rockets. “I went to Haiti last Christmas and visited some pretty dangerous parts,” Elon said. “I got wasted, too, on some drink they call the Zombie.”[51]

After returning from Haiti, Elon met with Dean Kamen, who had invented the Segway. Elon tried to convince him that the best place for Kamen’s next invention, a water purifier, would be Haiti. “[Elon is] really aware of where crises are, and he has a logical way he thinks out problems,” Mooser said. “When he heard about the water purifier, the first thing he said to Dean was, ‘Put it in Haiti.’“[120]

Another result of the trip to Haiti was the documentary *Baseball in the time of Cholera*, with Elon as the executive producer. The story is as follows: “As a Cholera epidemic rages in Haiti, the United Nations denies it is responsible for introducing the disease despite glaring evidence suggesting Nepalese peacekeepers are to blame. Baseball in the Time of Cholera is the story of a young Haitian boy who plays in Haiti’s first little league baseball team and the Haitian lawyer seeking justice against the UN. As the epidemic spreads, the two stories intersect in the struggle for survival and justice.”[107]

A devastating earthquake with a following tsunami hit Japan in 2011. After the close call disaster at the Fukushima nuclear power plants, everyone realized that Japan needed other energy sources more suitable for an earthquake zone. The Musk Foundation donated $250 000 to the construction of a solar power system in Soma City, 27 miles [43 km] from the damaged nuclear plants.

To prove the area was safe, sound, and open for business, Elon visited the city and shook hand with Mayor Hidekiyo Tachiya. While the solar panels were manufactured in Japan and installed by local workers, solar power specialists from SolarCity supported the project. “We are grateful to Elon Musk and the Musk Foundation for this generous gift, and for coming such a long way to personally visit Soma City,” Tachiya said. “Recovery

requires us to build new industries, and our next generation wants them to be supported by new kinds of energy. With this project as a beginning, Soma City hopes to become a model for Japan's energy future."[106]

Soma City wasn't the first solar power project by the Musk Foundation. "We're looking mostly at the US," Elon said. "We had also considered Haiti as a good option, but we found difficulties getting the system into the country without getting impounded."

In 2010, the Musk Foundation decided to build a solar power system for a hurricane response center in Coden, Alabama. The system would provide renewable power to an area devastated by both the *Hurricane Katrina* in 2005 and the *Deepwater Horizon* oil spill in 2010. The system will generate nearly 100 percent of the electricity needed, and with the help of a backup battery, the system will continue to generate electricity in the event of a power outage.[105]

Joining the Thrillionaires

Elon Musk is not the only rocket entrepreneur in the hood. A less public rocket man is John Carmack. Before he began launching rockets, he created the popular computer games *Doom* and *Quake*.

A year younger than Elon, many parts from Carmack's younger life resembled Elon's. With divorced parents, the young Carmack read books and comics. Like Elon, Carmack had a dark childhood and was bullied in school. After his schoolteacher introduced him to the Apple II computer, Carmack became mesmerized by the computer revolution. He enjoyed playing the games *Space Invaders* and *Asteroids*, and he sold his own computer games.[122]

Through the new medium Internet, Carmack discovered the different sides of chemical engineering. While both Elon and Carmack used their chemical skills to create rockets, Carmack also used his skills to make explosives so he could steal Apple II computers. But the police caught him and his friends in the act. "Boy behaves like a walking brain with legs… no empathy for other human beings," was the conclusion of his psychology evaluation.[122]

While Elon discovered himself in Canada by coming up with the three things that would affect the world, Carmack discovered himself while serving his sentence in a juvenile home. Carmack realized he didn't need to steal computers if he could make money by using his programming skills. The eureka moment came when he ported a popular Nintendo video game to the computer.

Carmack worked long days, and he loved the challenge to code the best games. The games were so good that after a concert, the Nine Inch Nails rock star, Trent Reznor, skipped drugs, beer, and women – he wanted to play *Doom* in his tour bus. As the games sold across the world, Carmack became a wealthy man. While the newly rich Elon bought the Jaguar, Carmack bought a cherry-red Ferrari 328. But everything didn't go smooth. In a similar way as when Elon forced Martin Eberhard to leave Tesla Motors, Carmack forced one of the co-founders, John Romero, to leave the company they founded.[122]

It was after an interview, where Carmack talked about his childhood, he rediscovered his interest in rockets. Carmack began with amateur rockets. “There are people who argue that you can just simulate reality, but I think there’s value in coming out here and dealing with the wind,” he said. “In the information age, the barriers just aren’t there. The barriers are self-imposed. If you want to set off and go develop some grand new thing, you don’t need millions of dollars of capitalization.”[122]

As the weeks passed, Carmack launched larger and more powerful rockets from abandoned parking lots. With the Ferrari as a transportation vehicle, Carmack filled his house with rocket parts. What really interested him was the programming challenges. In a similar way as when he challenged himself to always code the best games, he now wanted to code the best software for the control of the rockets. “You need enough pizza and Diet Coke to stick in your refrigerator, a cheap PC to work on, and the dedication to go through with it,” he said.[122]

Carmack read about how people thought NASA had become a trucking company. But he didn’t want to launch a truck – he wanted to launch a dragster into space. In the local amateur rocket website, he searched for members who wanted to build a vertical dragster, as he called his rocket, and thus Armadillo Aerospace was born. The rumors says that one of the reasons why he decided to start a rocket company was because he felt he wasted too much money on buying more and more customized Ferrari cars. At one point he owned four of them, but gave one away as a price in a gaming competition.[122]

Due to his interest in rockets, Carmack became a member of a new group of entrepreneurs called the thrillionaires. A member of the group believes it’s no longer good enough to have a slow private jet. What you need is a rocket.[121]

Another member of the group is Paul Allen who at age twelve tried to build a rocket. Using the ingredients needed from his chemistry set, he filled an aluminum armchair leg with the fuel mixture. The formula was correct, but he had not looked up the melting point of aluminum. “It made a great noise, and then melted into place,” he said. While growing up, he co-founded Microsoft. As Microsoft became a rather large company, he used his new wealth to invest in the company Scaled Composites that designed SpaceShipOne. It was the rocket that won the Ansari X Prize competition.[121]

He then co-founded Stratolaunch Systems that originally had SpaceX as customer before SpaceX decided to focus on their own rockets.[21]

The thrillionaire Jeff Bezos was five years old when he watched how astronauts landed on the Moon. “NASA is one of the few institutions I know that can inspire five-year-olds,” he said.[296] Bezos wanted to become an astronaut. While dreaming about how he one day would travel between the stars, he read books by Jules Verne, Isaac Asimov, and Robert Heinlein.[411]

Bezos never became an astronaut. Instead, he founded the world’s largest online retailer Amazon. But he’s still dreaming about going to space. “It’s always been one of his goals,” an investor in Amazon said. “It’s why he started working out every morning. He’s been ridiculously disciplined about it.”[411]

Like Elon, Bezos believes that we have all our eggs in one basket so we need to begin living on other planets. To fulfill the belief, he founded Blue Origin with the goal of dramatically lower the cost of rockets and increase the safety of technology that can get humans into space. The company’s motto is *Gradatim Ferociter*, which is Latin for “Step-by-Step, Ferociously.”[411]

Blue Origin came to the same conclusion as SpaceX: reusable rockets is the key to success in space. Named after Alan Shepard, who was the first American to travel into space and the fifth man on the Moon, Blue Origin’s rocket is called New Shepard. In a similar way as SpaceX’s Grasshopper system, the New Shepard can land and takeoff vertically.[411]

In 2012, Bezos announced that his company had found the engines from the Saturn V rocket that launched Neil Armstrong together with his crew to space. While the capsule continued to the Moon, the rocket landed in the Atlantic Ocean at a depth of 14 000 feet [4 300 m]. Bezos wanted to recover the remaining pieces.[296] “We’ve seen an underwater wonderland, an incredible sculpture garden of twisted F-1 engines that tells the story of a fiery and violent end, one that serves testament to the Apollo program,” Bezos said. “We photographed many beautiful objects in site and have now recovered many prime pieces. Each piece we bring on deck conjures for me the thousands of engineers who worked together back then to do what for all time had been thought surely impossible.”[295] After a three-week expedition, the engines were once again above the surface of the ocean. “Every time I see Jeff, I ask him why he’s not doing more in space,” Elon said.[67]

The type of competition between the companies founded by the thrillionaires can be defined as a friendly rivalry. They focus on developing inexpensive access to space, rather than wasting resources on trying to ruin each other. “Our competitors are not Paul Allen and Richard Branson, but Boeing, Lockheed, and the big aerospace companies,” Elon said. “I’m really glad to see all the activity in entrepreneurial space and hopefully this heralds a new era of space exploration with price and quality improvements similar to other technology arenas. I do think people will learn a lot from the suborbital RLVs [Reusable Launch Vehicle]. Of all the suborbital RLVs, I like John Carmack’s approach the best, as it has the clearest upgrade path to orbital capability.”[53,285]

Another competitor in the modern space race is Copenhagen Suborbitals. The 22-employee strong space venture from Denmark developed a rocket with the goal to launch themselves into space. They wanted to show the world that human space flight is possible without any major government budgets and administration. In 2011, they launched a rocket with a full-scale human model inside of the spacecraft Tycho Brahe, named after the Danish astronomer. But the rocket began to veer off course and had to be aborted 21 seconds after the launch.[398]

Elon’s long-term goal with SpaceX is to help, not only trained astronauts, but also ordinary humans to begin living on Mars. “The goal of SpaceX has been to advance technology to create a self-sustaining colony on Mars,” Elon said. “We have a long way to go and this is really hard work. It’s the most difficult thing humanity has ever done, but also the most interesting and inspiring.”[50]

To always be reminded of this goal, there’s a large photo of the red planet in the entrance to the SpaceX factory. There’s also a picture of how Mars will look like when the planet is colonized and transformed to be more Earth-like. “Over time you could terraform the planet and make it like Earth,” Elon said. “You heat the planet up by emitting green house gazes, kind of what we are doing on Earth. It will warm the planet up, thicken the atmosphere. The atmosphere on Mars is carbon dioxide, so as you grow plants, we convert the carbon dioxide into oxygen.”[4]

But why is Elon so fascinated by Mars? Except for Jupiter’s moons and the Moon, Mars is the only realistic object in space humans can land on. The

other objects realistically close enough have a too hostile environment making it impossible for astronauts to land. As Jupiter's moons are further away than Mars, the choices today are between the Moon and Mars.

Elon's vision is that we should begin living on other planets. From that perspective is Mars superior compared with the Moon. "On the Moon, you are missing a bunch of elements," Elon said. "Mars has the minerals and a tremendous amount of water in permafrost. If you could raise the temperature on Mars about 30 or 40 degrees Celsius, it would be under water. On the Moon, water is almost completely absent. Also gravity on Mars is closer to that on Earth."[60]

You can compare the difference between the Moon and Mars with the difference between the North Pole and America. The North Pole is closer to Europe than what America is, so why did we colonize America and not the North Pole? "Even though America was far away and it was a dangerous journey across the Atlantic, it still made much more sense to create a new Amsterdam in New York," Elon said.[446]

The temperature on Mars varies - a common temperature is minus 55 degrees Celsius [minus 67 degrees Fahrenheit] - so the first inhabitants have to endure extreme conditions. Elon compared it with living in a hotel lobby in Canada during the winter.[415] "It's true it's just rocks and gas, but we can make it nice," he said. "You'd have large domed living areas, where you could create parks with trees. You're at a higher level of radiation exposure, so there would be some increased risk of cancer. I mean it's way more difficult than living on Earth. But we have to do it."[4]

"I think we could potentially send someone to Mars as soon as ten years, and I'd be disappointed if it took us longer than twenty," Elon said in an interview from 2011. Elon himself will not be one of them. "I used to do quite dangerous things, like flying a fighter jet at low altitude," he said. "Then I had kids and companies and I want to see them grow up, so I've curtailed my dangerous activities. I'd like to go up, but I won't be the first."[314]

Maybe Elon remembered his grandfather Joshua's tragic aircraft accident when he in 2005 decided to sell his fighter jet. "Sadly, I don't pilot myself anymore," he said. "I have to work when I fly and have too many thoughts in my head to pay the necessary attention to the plane – I can be absentminded at times, which is a really bad habit for a pilot."[399]

A manned voyage to Mars will probably be a collaboration between SpaceX and NASA. “If we do SpaceX right, NASA will use it for human exploration of space, and that is the ultimate goal,” Elon said.[60] In comparison, about half of the financing for Christopher Columbus voyage came from private investors, while the other part came from an almost broke Spanish government.

Columbus had to convince his financiers he would bring back treasure from India to get the ships needed to travel west. SpaceX, however, will not try to bring back treasure from Mars. It will always be far cheaper to mine on Earth compared with first mining on Mars and then transport the commodities to Earth. “There are a couple of things I think are pretty bogus,” Elon said. “One is space mining, another is space solar power. If you calculate how much it cost to bring either the photons from space solar power back to Earth, or the raw material back to Earth, the economics don’t make sense.”[364] He added that mining asteroids could make sense, but a mission to Mars will not be dependent on the ability to mine asteroids.[356]

A company believing in the idea to mine asteroids is Planetary Resources. The company argued that 1 500 asteroids are as “easy” to reach as the Moon. These asteroids are filled with precious resources, everything from water to platinum. “We expect to mine water out of C-type asteroids for the first product,” an engineer from Planetary Resources said. “Water gets used for everything in space – drinking, breathing, rocket fuel, radiation shielding… and is very expensive in space given launch costs. Structural materials would likely be second – bulk material is expensive in space. After that, we would look into mining materials that are scarce on Earth. Those have industrial uses that are likely to grow as world’s economy grows.”[377]

One of the advisers to Planetary Resources is the film director James Cameron. When Elon founded SpaceX, he held seminars at the Mars Society together with Cameron, who has directed movies like *Titanic* and *Terminator*.[60] Cameron would like to visit Mars and he believes we humans have to begin living on other planets if we want to survive. “If we discovered a comet nucleus or an asteroid on an impact course with Earth, we could do exactly what the dinosaurs did, and we could stare upward with a dumb look on our faces,” he said. “We need to evolve beyond the dinosaurs.”[415]

To increase our interest in space, Cameron believes the space industry should contact Hollywood to make the space more visually dramatic. He compared it with his movie *Titanic*. The images we see from space today are

similar to if we had watched the *Titanic* movie through Leonardo DiCaprio's eyes. It wouldn't have been a good movie.[415]

Cameron has a movie script ready for a new movie about Mars. This time a more realistic movie compared with the earlier movies with a Mars theme. "The Mars movies have been so bad," Elon said. "I mean, honestly. And it's going to be tricky getting funding for another Mars movie after John Carter. It was a good comic book, and they totally screwed up the movie."[316]

When we tried to reach the Moon in the 1960s, some argued that landing on the Moon would be the noblest expression of the century, while other argued it would be the high mark of the fundamental insanity of the time. You can today hear the same reasoning regarding a manned mission to Mars. "Since 1989, when a study estimated that a manned mission [to Mars] would cost $500 billion, the subject has been toxic," Elon said.[305]

Traveling to space is expensive. Elon argued it's worth the same amount of money we put on lipsticks or cosmetics each year, but less than what we spend on health care.[350] The former US President John F. Kennedy made a similar comparison. "This year's space budget is three times what it was in January 1961, and it is greater than the space budget of the previous eight years combined," he said. "That budget now stands at $5 400 million a year – a staggering sum, though somewhat less than we pay for cigarettes and cigars every year."[19]

"Some money has to be spent on establishing a base on Mars," Elon said. "It's about getting the basic fundamentals in place. That was true of the English colonies [in America]; it took a significant expense to get things started."[313] But after things got started, the infrastructure in America improved each year, and it became cheaper and faster to travel across the Atlantic Ocean. The reason *Titanic* collided with an iceberg was that the owner demanded that their ship should be the fastest across the Atlantic Ocean. In a similar way, future spaceships will compete in who can travel the fastest from Earth to Mars, hopefully without colliding with an asteroid.

Several old ideas on how to travel to Mars are collected in the book *Humans to Mars: Fifty Years of Mission Planning*. Wernher von Braun wrote the novel *The Mars Project* about an expedition to Mars. His idea was to build ten spaceships in space in a similar way as when the International Space Station was constructed. 950 rockets had to be launched from Earth to get the parts and fuel up to space. Von Braun found inspiration for this project from the large Antarctic expeditions. Between 1946 and 1947, an army of 4 700

men, 13 ships, and 23 airplanes participated in the expedition Operation High Jump. No satellites were available at the time, so the Antarctic explorers were isolated from the world in a similar way as the Mars explorers would be.

These earlier attempts to reach Mars remained at the project stage. What the visionaries would have needed was capital and experience from large technological enterprises. Elon may have experience from large technological enterprises, but lacks the capital. But as SpaceX's rockets improve, they will make more money by launching cargo, satellites, astronauts, and tourists, so in the end there will be a mission to Mars.

The organization Mars One has the vision to establish a permanent human colony on Mars. To help them get the material and astronauts to Mars, they say they will use rockets from SpaceX. Their idea is to launch the first rocket with supplies in 2016, and then will more rockets launch with supplies until the first humans arrive in 2023. In 2033, the colony will have 20 settlers. The money needed to pay for this mission will come from sponsors and a reality television series. As of 2013, more than 100 000 people have applied to be a part of this mission.[390]

When people have begun living on Mars, SpaceX will build a large cruiser that will travel between Earth and Mars, most likely called the Mars Colonial Transporter. The cruiser will never land on any plant, so to get to the surface, a smaller craft will come and pick you up from the cruiser. "It would take six months to get to Mars if you go there slowly, with optimal energy cost," Elon said. "Then it would take eighteen months for the planets to realign. Then it would take six months to get back, though I can see getting the travel time down to three months pretty quickly."[278] In comparison, it took a sailing ship more than nine weeks to cross the Atlantic Ocean in the 17th century, but it took the Concorde only three hours in the 21st century.[13]

When both the price and the time of the journey to Mars decreased, more volunteers will be motivated to emigrate from Earth. Elon argued that if you can reduce the cost of moving to Mars to around the cost of a middle class home in California, or around half a million dollars, then enough people would buy a ticket and immigrate to Mars. "You obviously have to have quite an appetite for risk and adventure," Elon said. "But there are seven billion people on Earth now, and there will be probably eight billion by the midpoint of the century. So even if one in a million people decided to do that, that's still 8 000 people. And I think probably more than one in a million people will decide to do that."[288]

To help mankind become multi-planetary, the first step is to colonize Mars, but Elon has larger plans. “Having a base on Mars, where there is a lot of travel to and from Earth, will create a powerful incentive for developing technology that will enable us to travel to other star systems,” Elon said. “With a nuclear thermal rocket you could definitely reach a tenth of the speed of light. There are some interesting things I’ve seen lately about warp drives. You can’t exceed the speed of light but you can warp space and effectively travel many times the speed of light. That’s kind of exciting.”[314]

Idea Overload

Now this is not the end. It is only the end of the beginning. “I think that it is possible to solve any of the problems that are before us. I don’t think we are doomed on Earth,” Elon said. Therefore, he will continue to come up with new ideas as long as he can. “The goal is to retire right before senility,” he said.[328]

But what does Elon do to find a problem to solve? There are a number of methods you can use to find new ideas. Walt Disney used to go through trashcans to find out what people threw away, and he tried to find new ideas from the garbage.[30] Thomas Edison found several ideas when he was almost asleep. To wake up just after falling asleep, he held steel balls in his hand. When he fell asleep, his hand relaxed and released the steel balls. They hit the floor, and he woke up again from the noise. He immediately wrote down his thoughts.[31]

A British survey with 500 entrepreneurs showed that 49 percent found new ideas while in their bed, 72 percent found new ideas while at work, 57 percent found new ideas while talking to friends, and 41 percent found new ideas while at the toilet. “I realized recently that what one thinks about in the shower in the morning is more important than I’d thought,” an entrepreneur said. “I knew it was a good time to have ideas. Now I’d go further: now I’d say it’s hard to do a really good job on anything you don’t think about in the shower.”[32]

Elon has found some ideas when he took a shower, some ideas late at night when he couldn’t sleep, and some ideas when he attended Burning Man. “It’s something of a cliche, but a lot of my ideas nowadays come to me when I’m in the shower,” Elon said. “It’s because I’ve been thinking about them, the mind processing them subconsciously while I’m sleeping, and what’s the first thing you do when you get up in the morning? You take a shower.”[128]

Almost all the larger ideas originates from when Elon read articles about a topic he thought was sad. “I thought it was quite sad that the Apollo program represented the high water mark of space exploration,” Elon said. “It

was not something I was able to witness in real time, because I was -2 when they landed."[339] So he founded SpaceX to not be sad anymore. "You want to have a future where are you expecting things to be better, not one where you are expecting things to be worse," Elon said. It would have been sad to have a future where we didn't have any cars because we have used up all our oil wells. That's why Tesla designed Model S.[124] "What we were really aiming to achieve with the Model S is to create a car – an electric car – that was the best car. Not the best car among the electric genre, but the best car overall," Elon said.[193]

When Elon read an article about the decommissioning of the Concorde, he felt sad because we traveled slower. To solve the problem, he came up with an electric aircraft. It had to be electric because of peak oil. "Boeing just took $20 billion and ten years to improve the efficiency of their planes by ten percent," Elon said. "That's pretty lame. I have a design in mind for a vertical liftoff supersonic jet that would be a really big improvement."[51]

After some engineering calculations, he realized the new aircraft should fly at an extreme altitude because the density of the air drops as higher you fly. The performance of the electric aircraft will thus improve. While an electric aircraft should fly at an altitude of 80 000 feet [24 km], the optimal altitude for a combustion aircraft is 40 000 feet. "In order to go fast, you need to be at high altitude where the air drops exponentially, as air at sea level becomes as thick as molasses as you approach sonic velocity," Elon said.[401] Like a helicopter, this new aircraft will takeoff and land vertically.[328]

While commuting in Los Angeles, Elon found another sad problem. Some highways in Los Angeles have ten traffic lanes, but the traffic situation is still horrible. Elon explained that it's easier to launch rockets into orbit than to commute between his home in Bel Air and SpaceX in Hawthorne – a distance of 15 miles [24 km] as the crow flies. "The 405 varies from bad to horrendous," Elon said. "It just seems people in Los Angeles are being tortured by this. I don't know why they aren't marching in the streets."

A double-decker-highway is Elon's solution to his commuting problem. The second deck will consist of a cheap metal construction dropped on the top of the original highway. It will increase the capacity with 100 percent. To speed up the idea, Elon contributed with $50 000 to a group seeking to hasten the development and repair of infrastructure in the US. "If it can actually

make a difference, I would gladly contribute funds and ideas. I've super had it," Elon said.[184]

While SpaceX is in Los Angeles, Tesla is in San Francisco. Because Elon only owns a house in Los Angeles, and it takes too long time to fly home when he has worked at Tesla, he often sleeps over at one of his friends. "We play video games together and eat some food," Bill Lee said, who was an early investor in both SpaceX and Tesla.[51]

To travel between SpaceX and Tesla, Elon uses his private jet because it takes too long time to drive. Flying a jet is not to save the world from its dependency on oil, so there's clearly a need for a new type of transportation between the cities that's more environmental friendly than an aircraft and faster than a car. The state of California had the same idea and decided to build a bullet train between San Francisco and Los Angeles. But the train wouldn't be a bullet. "Because the $60 billion bullet train they're proposing in California would be [one of] the slowest bullet train in the world at the highest cost per mile," Elon said. "They're going for records in all the wrong ways. Why are we, in the center of high tech, doing such a bad job [with transportation]? It's embarrassing. It says all sorts of wrong things about our state."[51]

Elon thought the story about the bullet train was sad, so he came up with the Hyperloop. "I was thinking about what could be better, state of the art?" Elon said. "That's where I came up with the idea for a fifth mode of Earth transport, apart from planes, trains, automobiles, and boats. The Hyperloop could go from city center to city center [San Francisco to Los Angeles] in not much more than a half-hour."[316] While the California bullet train will cost $70 billion, Elon thought the Hyperloop would cost only $7 billion.[401]

The Hyperloop was a secret project and Elon didn't want to reveal any major details when asked to do so by reporters. But the Hyperloop was finally revealed in August 12, 2013. The released document is not the final document as Elon's idea is to give away the basic idea to anyone who wants to build it. "I just want to put it out there in a way that doesn't require me to do day-to-day execution," Elon said. "I would like to do less, actually. I tried my hardest to avoid being CEO of Tesla. Running two companies is not the most fun thing in the world."[400]

If no one shows any interest in the idea, Elon will probably build a smaller prototype of the Hyperloop to get things moving. If he wasn't the CEO of two companies, it would have taken one to two years to build this

prototype. Then it would take another five years before we could travel between San Francisco and Los Angeles in 35 minutes.[400]

The Hyperloop is a glorified roller coaster with two stations. “It’s like getting a ride on Space Mountain at Disneyland,” Elon said.[403] Single pods leave the stations continuously and travels inside of a steel tube. There are two tubes, one in each direction, and the tube sits on the top of concrete pillars. The idea is to construct these pillars along an already existing highway to avoid spending money and time on purchasing new land.[401]

The optimal environment inside of the tube would have been vacuum, but it’s incredible difficult to create a vacuum inside a long tunnel. A better idea is to use pumps to maintain a low-pressure environment inside the tunnel. The problem with a low-pressure environment is the air in the tube. Everyone who has traveled by subway learned that a subway train has to push air through the tunnel to move forward. The wind almost blows you away when you are waiting for a train. Some Indian engineers have by the way an idea to use this wind to generate electricity by installing wind turbines.[402] To overcome this problem of having to push air, Elon said it’s possible to install a fan on the nose of the pod that transfers air from the front to the rear of the pod. This fan will also produce an air cushion, so the pod doesn’t need any wheels.[401]

To power each pod, the Hyperloop will use the same batteries as in a Tesla car. But the batteries will not propel the pod forward - just power the internal electronics. To achieve speeds of 760 mph [1 220 km/h], linear electric motors will be used. A linear electric motor produces a linear movement, while a traditional electric motor produces a rotational movement. There’s no need to accelerate each pod continuously, so linear electric motors will cover about one percent of the total length of the tube. Solar panels positioned on the top of the steel tubes will supply power to these linear electric motors.[401]

Each passenger has to pay $20 to get a ticket to travel in one of the pods for 35 minutes to get from Los Angeles to San Francisco. The same trip with a car would have taken 5 hours and 30 minutes, 2 hours and 40 minutes with the proposed bullet train, or 1 hour and 15 minute by aircraft.[401] “Unlike an airplane, it is not subject to turbulence, so there are no sudden movements. It would feel supersmooth,” Elon said.[403] But we will still use aircraft for

longer distances as the optimal length of an Hyperloop is 900 miles [1 500 km].[401]

The released report argued that the pods could come in one of two sizes. The smaller and thus cheaper pod can carry 28 passengers. The larger more expensive pod can carry as many passenger as the smaller pod, but also three cars with the same size as a Model X from Tesla. Since the major problem with electric cars is that they are difficult to travel with over long distances, it would be much easier if you could transport the car with the Hyperloop.[401] "You just drive on, and the pod departs," Elon said.[403]

The Hyperloop and Elon's other projects share a common thread: they solve large and difficult problems. Zip2 might have begun as a smaller idea since the founders needed to make money as fast as possible. But as time passed, Zip2 grew and Elon said the company could have become as big as Yahoo. X.com competed with America's largest banks. SpaceX has the goal to colonize Mars. Elon's plan with Tesla was to reinvent the highly competitive car industry by building General Motors 2.0. SolarCity and Tesla are saving the world from its dependency on fossil fuels. Both the electric aircraft and the Hyperloop are so innovative that no one is trying to design something similar. "The bottom line for me, which I don't let myself forget, is that challenges are what drive me above all – the challenge of creating things that I hopefully will get a chance to look back on and be proud of," Elon said.[265]

But Elon has nothing against the smaller ideas that may not affect the world in a similar way as the larger ideas. "They provide a small amount of value to a lot of people, and that sums up to something – that's still good, it makes their lives better," he said.[68] He recommended that if you have the ambition to change the world with one of these larger ideas, then you should begin with a smaller idea within the Internet or software industry. New companies in these industries tend to require little initial capital. "Unless you've got a ton of capital that someone gave you or you've inherited, you have to start a company that requires a small amount of capital," Elon said. "It would have been impossible for me to have done electric cars or rockets right from the start."[437]

Finding a problem to solve is only step one. Step two is to find a solution to the problem. "The way I tend to view problems is from a physics

standpoint," Elon said. "I think that physics is a good analytical framework. One of the key things in physics is to reason from first principles. This is contrary to the way most human reasoning takes place, which is by analogy ['We'll do that because it's always been done that way' or 'Nobody has ever done that so it must not be good']. Reasoning from first principles just means that you figure out what are the fundamental truths, and can you build up a conclusion from that? Reasoning by analogy is helpful because it's a shortcut, and is mostly correct, but tends to be mostly incorrect when you are dealing with new things."[357]

You can first say that battery packs for electric cars will always be expensive because they have always been expensive. From a physics standpoint, you can break the batteries down into the materials they are made of, and then ask what the value is of those materials on the commodity market. You will now realize the material is not as expensive as the final battery pack, so you just have to come up with a way to improve the manufacturing process.[324,354] "Data informs the instinct," Elon said. "Generally, I wait until the data and my instincts are in alignment. And if either the data or my instincts are out of alignment, then I sort of keep working the issue until they are in alignment, either positive or negative."[22]

When you have found a solution to a problem, the next step is to create a company. In a creative company, it's important to allow a certain amount of chaos. In most organizations, failures are severely punished and successes are moderately rewarded, and that's not a good idea if you want to be innovative. Innovations originates from many attempts that haven't worked. "Because when you try new things, you try this idea, that idea," Elon said. "Well, a large number of them are not gonna work, and that has to be okay. If every time somebody comes up with an idea it has to be successful, you're not gonna get people coming up with ideas."[354]

To nurture creativity in their company, Google came up with the "20 percent time," where employees can work with what they want for one day each week. "I think Google has been pretty good at this by allowing people to take Friday every week to work on some crazy project," Elon said. "I think that's a good idea, I think we will probably implement something like that at SpaceX and Tesla. Lots of employees have great ideas, and if they can simply get the resources to implement them."[360]

Like when Elon believed in a small government, he's neither a fan of big companies, partly because of his own experience from an internship.

“They didn’t have just one coffeemaker there, they had a special coffeemaker for the executives. An executive coffeemaker,” he said.[263]

While Steve Jobs wanted his Macintosh-group to act like pirates, Elon want his companies to act like the special forces. SpaceX is like Top Gun and Tesla Motors is like Delta Force. “We do the missions that others think are impossible,” Elon said. “We have goals that are absurdly ambitious by any reasonable standard, but we’re going to make them happen.”[24] In comparison, NASA is like a navy and General Motors is like an army. “It’s better to be a pirate than to join the navy,” Jobs said.[3]

General Motors argued that as Tesla grows, it would be difficult to act like small organizations. You can’t organize an entire army in the same way as you organize Navy Seals. “Inevitably, Tesla will discover that the only way to succeed on the scale we have is to be exactly like us,” they said. “The total of all Tesla cars ever produced since 2006 [to 2012], from the initial announcement of the electric Roadster to the current Model S sedan, amounts to a couple of hours of GM’s global production. The company’s earnings from that effort likely amount to a similarly minute fraction of GM’s business.”[59,376]

Since the special forces are recruiting only the best, Elon’s companies are also recruiting only the best. “I have never worked for another aerospace company,” Elon said. “However, based on stories I’ve heard, some of them sound like a Dilbert cartoon in real life. My approach is simply to seek out very talented people, ensure that the environment at SpaceX [and Tesla] is as motivating and enjoyable as possible, and establish clear and measurable objectives.”[285]

What Elon is looking for is the Michael Jordans of engineering. The employees need to have a positive attitude, they have to be easy to work with, and the other employees have to enjoy working with them. There’s a no-asshole-attitude, so C or D employees are not tolerated on a scale where A employees are the best. He will fire C or D players, but not without first giving a warning. What Elon want is happy employees. If an employee is not happy, then he or she can no longer work for the company.[354] “If you are not happy, get a divorce,” Elon said, probably as a reference to his two failed marriages.

But A players within certain fields are not always easy to find. “There’s certain special skills, especially in advanced engineering, that are the limiting factor in creating new companies; we send these people home after training

them in our graduate schools," Elon said. "One of the toughest things I've found is to recruit top-notch manufacturing talent. That's where I've had to go overseas. For a few decades, it just wasn't where the smartest kids in the class in America went. We had far too many smart people in the US go into finance and law."[316]

Being the best doesn't just mean that you were the best in school. What you need is real experience. Elon recalled how he interviewed fresh graduates without any experience. "So you get all the arrogance and attitude without any of the capability, or the willingness to admit mistakes, adapt and learn," Elon said. "They need to go spend a few years at a Fortune 500 company, where everybody is like them, they have no status whatsoever and they're treated like dirt. They get seasoned and humbled. Then you can work with them."[167]

End of the Beginning

The French emperor Napoleon Bonaparte met with his advisers who recommended him a new general to lead a new military campaign. The advisers told Napoleon that the prospective general was good with the men, he was smart, and he had excellent tactics. Napoleon looked at his advisers and asked “Yes, but is he lucky?” For entrepreneurs, luck is important, but so is good tactics, and you need to be good with the men and women in the organization.

Elon answered the question if you create a successful company it’s more about the external environment than any skill the entrepreneur has. “I’m just very lucky,” Elon replied. “Definitely luck plays a role in anything. I do think you’ve got to have perseverance. You’ve got to stick it out, and the team that you’re working with does, too. That allows you to get through a series of issues. It took us four flights to get to orbit at SpaceX. That was kind of grueling.”[57]

Because all rocket launches after the first three flights have been successful, it looks like SpaceX might have passed the first stage where a new company has to fight for its survival. SolarCity had some minor troubles in the beginning, but has been fine since then. “Solar City is doing super well,” Elon said. “They’re growing at 50 percent to 100 percent a year with positive cash flow, which is pretty incredible. I just show up at the board meetings to hear the good news. It’s really great.”[351] The third company, Tesla Motors, had as we now know a few ups and downs but is today also on the right track. “It feels good in retrospect, but it was extremely difficult and stressful at the time,” Elon said. “It’s really this year [2013] I’ve felt really secured about Tesla. Tesla is now ten years old, so the first nine years were quite insecure.”[445]

When Elon co-founded Tesla, he had a vision: “I would like to be able to look back and say: Tesla accelerated the transition from hydrocarbons to sustainable electric transport by at least five to ten years.” This vision is now a reality. “We’re still very little, and so while the big automakers won’t be afraid of us, they should be afraid of their competitors imitating us,” Elon

said. “Our success will make Toyota worry about what BMW will do, and GM worry about Honda – will create a concern about being late for the party. So our role is as a guiding light, helping bring these cars to market five or ten years faster than they would have otherwise – which could make an important difference for saving the species.”[59]

The Model S won the 2013 Motor Trend’s *Car of the Year* award, which is a competition that began in 1949. “I did a double-overhead high-five with George Blankenship, who told me the news,” Elon said. “Hopefully, what it will mean to the public is something very powerful. It should symbolize the transition to electric. Motor Trend’s Car of the Year award is the top award, obviously, in the car industry and the most respected, so for Motor Trend to say that the Model S is, in fact, the best car is a huge vindication and, I think, what will be hopefully seen historically as a turning point in the transition from gasoline to electric.”[193] The Toyota Prius won the competition in 2004 and Chevrolet Volt won it in 2011.

While the Chevrolet Volt is not a true electric car, it has a small combustion engine in reserve, it’s a first step. General Motors admitted they started the Volt program as a direct response to the Tesla Roadster.[355] “All the geniuses here at General Motors kept saying lithium-ion technology is ten years away, and Toyota agrees with us – and, boom, along comes Tesla,” Bob Lutz of General Motors said. “So I said, ‘How come some teeny little California start-up run by guys who know nothing about the car business can do this, and we can’t?’ That was the crowbar that helped break up the logjam.”[59]

Elon is not a fan of the Volt. The Volt’s battery pack is half as large as the Roadster’s, but has only one sixth of the electric range. “You’ll have a tiny engine pulling around a big car with a dead battery – you’ll be the worst car on the road,” Elon said of what will happen if the Volt’s battery runs out of juice.[59] And Lutz is not yet a fan of Tesla. “This is a little bit like saying that a new, exclusive, high-end restaurant in New York, with a three week reservation list, is ‘doing a better job’ in the food business than McDonald’s, Burger King, Wendy’s, and Pizza Hut combined,” he said.[376]

One of the executives who was blamed for killing the EV1 was Lutz. He received e-mails like, “You sold out to the oil companies,” “You killed my grandchildren,” and “I hope you rot in hell.” He has now changed his mind, and he calls himself an environmentalist within reason.[331] Elon is also an

environmentalist within reason. “I’m not too hardcore about being green,” Elon said. “I think it leads to a very constrained life. Waste is not good, but we can’t conserve our way to a solution. If everyone were a super-green conservationist, it would just delay the inevitable. We have to find sustainable means of producing and consuming energy.”[373]

The third co-founder who decided to leave Tesla was Ian Wright; the other were Marc Tarpenning and Martin Eberhard. Wright felt his vision was different from Tesla’s and wanted to build an electric vehicle based on a different technology, so he decided to leave the company after only a year.[384] With the vision to build the fastest electric vehicle, he founded the company Wrightspeed. “I want to build an extreme performance electric sports car, faster than any production car you can buy for less than one million dollar,” Wright said. “This would be zero to 60 [100 km/h] in three seconds.”[207]

Unfortunately, Wright couldn’t convince anyone to invest in his sports car. Instead, he decided to target the truck industry. He realized that when you operate a delivery truck, you replace the truck’s engine several times throughout its lifetime. When you replace the old gasoline engine, why can’t you replace it with a clean electric engine? This is what Wrightspeed set out to do when they developed a plug and play repower kit for trucks.[26]

The designer who first designed the Model S, Henrik Fisker, has left Fisker Automotive and the company struggles for its survival. 75 percent of the workforce had to leave the company in April 2013, and they continue to negotiate with prospective investors. “Fisker thinks the most important thing in the world is design, so he outsourced the engineering and manufacturing,” Elon said. “But the fact is that’s the crux of the problem. And he’s outsourcing to people who don’t know how to solve the problem. So he came up with a product – it’s a mediocre product at a high price.”[190]

Elon’s second ex-wife, Talulah Riley, has moved back to his house. She promised Elon to retire with him on Mars – but only if Elon has colonized the planet. After she came back, Elon designed an engagement ring. It has a diamond in the middle that symbolizes Elon and Riley, and the sapphires around it are the ten children, out of which five are not yet born.[129] You can apparently save the world in more ways than with technology. “People have to make sure they have at least as many babies as people who die,” Elon said. “The death rate has to equal the birth rate. Otherwise you get a population

inversion, which is what happened in Japan and is happening in Europe, where there are birth rates of 1.2, 1.3 children per woman. You need 2.2 to retain parity."[301]

Riley explained that her current job is to prevent Elon from going king-crazy. This is a British expression and it means that a person becomes the king, which Elon has become in a way, and then the king goes crazy.[278] "I think I'm probably am a bit crazy, but maybe that's sort of a healthy sign, because at the point which you conclude that you are not crazy at all, then you probably are," Elon said.[328]

Some say Elon has already gone king-crazy, and some say he's using government money to enrich himself by creating companies that are hidden Ponzi schemes.

"Soon that company besmirching the name of one of the 20th century's most important inventors, will be as dead as he is. The difference will be that the man [Nikola Tesla] accomplished much, and left us with mysteries researchers are still exploring. The company will just leave a bunch of empty pockets and a few cobbled-up cars."[203]

"He's going to send somebody to Mars for $500 000? That's just baloney. It's just bullshit. Why do people allow him to say things like that?"[120]

But Elon couldn't care less about what others are saying about him, and insanity is after all more logical than sanity when you attack a problem. As Apple's *Think Different* commercial said.

> Here's to the crazy ones. The misfits. The rebels. The troublemakers. The round pegs in the square holes. The ones who see things differently. They're not fond of rules, and they have no respect for the status quo. You can quote them, disagree with them, glorify and vilify them. About the only thing you can't do is ignore them because they change things. They push the human race forward. And while some may see them as crazy, we see genius. Because the people who are crazy enough to think they can change the world, are the ones who do.

So someone like Elon has to endure more criticism because his ideas are changing the world. But if you care enough about your ideas then it doesn't matter what the rest of the world thinks. "For me it was never about money,

but solving problems for the future of humanity," Elon said. "If I was purely trying to optimize my net worth, I wouldn't have picked these as ventures. I'd be in real estate or finance or, frankly, in the oil business. There's nothing wrong with making money, provided it's done in an ethical and legal manner, which it mostly is. The things we read about in the newspapers are the exception, not the norm. But we need to consider what it's all about. What is the meaning of life? Are we doing things that extend the scope of collective human knowledge and understanding? We should do the things that lead us there. I'm not trying to paint myself as some sort of saint. I'm just making the point that the success of the company doesn't change my life. These are the problems that I think are important and need to be solved, and I'm trying to help solve them."[22,50,69]

Timeline

Elon Musk

1971.Born in Pretoria, South Africa, June 28

1983.Designed a computer game and sold it for $500

1989.Moved to Canada, in part to avoid a compulsory military service in South Africa

1990.Began studying at the Queen's University in Ontario

1992.Moved to the US to study at the University of Pennsylvania

1995.Began a graduate program in applied physics and materials science at the Stanford University. Left Stanford after two days and founded Zip2

1999.Compaq's Altavista division acquired Zip2. Founded X.com

2000.X.com acquired Confinity in a 50/50 merger. Married Justine Wilson. Left X.com as CEO

2001.X.com changed its name to PayPal. Established the Musk Foundation to provide grants for renewable energy, space, and medical research and also science and engineering education

2002.eBay acquired PayPal. Founded Space Exploration Technologies (SpaceX)

2004.Invested in Tesla Motors. The twins Griffin and Xavier were born

2006.The triplets Kai, Damian, and Saxon were born. Co-founded SolarCity

2007.Sold the McLaren F1

2008.Became CEO of Tesla Motors. Divorced Justine Musk and met Talulah Riley

2010.Married Talulah Riley. Had a small role in the movie Iron Man 2

2012.Divorced Talulah Riley

Tesla Motors

1900.38 percent of US automobiles are powered by electricity, but as Henry Ford designed the much cheaper T-Ford, the electric cars began to disappear

1970s.The price of gasoline hits record because of a series of energy crises, so the interest in electric cars increased again

1996-1999.General Motors produced an electric car called EV1 and leased it to customers

2002

- January. Martin Heberhard and Marc Tarpenning founded Tesla Motors with the goal of reinventing the electric car and transforming traditional car manufacturing into a clean technology industry

2003

- General Motors canceled the lease program and removed the last EV1 from the streets. They said they couldn’t sell enough of the cars to make the EV1 profitable
- July. Martin Heberhard and Marc Tarpenning formally incorporated Tesla Motors. They had earlier made a feasibility study to see if they could make an electric car. They now made a feasibility study together with AC Propulsion to see if the batteries would work
- November. The 2 employees searched for a partner to build the rest of the car. Lotus became their choice

2004

- February. Ian Wright, who had met Martin Eberhard while on a plane, joined the company. They finished business plan 1.0
- March. Starting a car company is expensive, so they began to look for outside investors
- April. Series A funding where Elon Musk was the main investor. Other investors included SDL Ventures and Compass Technology Partners. JB Straubel joined the company as employee number 5
- May. An early styling study began
- June. A technology implementation study began
- July. Tesla had 9 employees and moved to an office in San Carlos, California. They also made a "mule" which is a car that doesn't reproduce but you can see if the concept works. To design Mule 1 they bought an old Lotus Elise
- October. The 15 employees began to design the drive-train component
- November. They installed the drive-train in the Mule 1
- December. Tesla couldn't use the same design as the Lotus Elise, so they had a contest where Barney Hatt made the best design

2005

- January. They made a 1/4 scale model in clay of the design Barney Hatt had made. Tesla had now 18 employees and they also took out Mule 1 for a test drive
- February. The now 23 employee strong company needed more money, so they made a series B funding. Not only Elon Musk invested more money, but also Valor Equity Partners. Tesla also opened an office in UK close to the Lotus office
- April-June. Tesla made a full-scale model in clay of the Tesla Roadster
- July. With 38 employees, they now tested a plastic model of the Roadster in a wind tunnel
- August. Some of the 41 employees began developing a motor
- December. 63 employees and they began to build the Mule 2 in fiberglass

2006

- January. A drivable Mule 2 was finished
- April. The engineers thought the Roadster was finished so they made 10 engineering prototypes (EP), which compared to a Mule can (in theory) be produced
- May. 92 employees and they finished the first EP, called EP 1. Tesla raised a series C round led by Vantage Point Partners and Elon Musk
- July. Almost no-one knew that Tesla existed, until now when Tesla showed EP 1 and EP 2 in Santa Monica, California
- August. 100 employees. Why did they make 10 EPs? So they could test-crash a few of them. Tesla had earlier crashed a few virtual cars, but they needed to know if the computers models were accurate. They also began to show the Roadster at events to market it
- September. 120 employees. They made more tests, including radiated emissions and susceptibility testing
- October. They made a durability test, which consists of driving the Roadster on a cobblestone racetrack. The idea is to simulate 100,000 miles in 6 months. It would have taken much longer time to drive the same distance on a smooth road. Tesla realized that their computer models were inaccurate - the Roadster's transmission didn't survive the durability test
- November. 144 employees, and more tests, including driving through a saltwater bath
- December. They showed the EP 2 at the Los Angeles Auto Show

2007

- January. Tesla brought the Roadster to Arvidsjaur, Sweden, to see if it could survive winter conditions
- February. 205 employees. Tesla began to build a validation prototype (VP), where they took everything they learned from the engineering prototype. Tesla says it will build a $35 million plant in Albuquerque, to produce the Model S
- March. 230 employees and they finished the VP 1
- April. Raised more money - a series D round led by Elon Musk, Technology Partners, and Vantage Point

- June. Tesla's motor factory in Taiwan was finished and it began producing parts
- July. A new transmission was finished
- August. Tesla finished the VP 10. CEO Martin Eberhard was replaced by Tesla investor Michael Marks, who would work as an interim-CEO until Tesla found a long-term CEO
- September. Tesla delayed the launch of the Roadster because they needed more time to test its durability
- October. It turned out that also the new transmission failed in the durability test. Tesla needed yet another transmission
- November. Martin Eberhard had to leave the company
- December. Interim CEO Michael Marks was replaced by interim CEO Ze'ev Drori

2008

- January. 260 employees. The VPs survived the new tests, so the Roadster was finished - except for the transmission
- March. Tesla began production of the Roadster
- April. More money - a bridge financing led by Elon Musk and Valor Equity Partners
- May. Opened a retail store in Los Angeles, and they also finished a new transmission
- June. Opened a second retail store in Menlo Park, California, and they also delivered the first Roadster to the customers. Marc Tarpenning decided to leave Tesla. The Model S was announced in a press release
- August. Franz von Holzhausen joined Tesla Motors as Chief Designer
- October. Elon Musk became the CEO after interviewing more than 20 prospective CEOs
- November. Tesla revealed it had requested about $400 million in loans for the Model S and powertrain manufacturing, under the Department of Energy's Advanced Technology Vehicles Manufacturing (ATVM) program

2009

- March. Tesla unveiled two Model S prototypes at the Los Angeles headquarters of Tesla CEO Elon Musk's other startup, SpaceX. Tesla had decided to build a design studio at the factory. Tesla began taking reservations for the Model S. More than 500 people reserved the car in the first week
- June. Tesla got approval for $465 million in low-interest loans from the Department of Energy

2010

- January. Tesla registered for an initial public offering of stock
- May. Tesla bought NUMMI - a former Toyota and General Motors factory in Fremont, California, for $42 million. Toyota Motors and Tesla announced they will cooperate on electric vehicle development. Toyota purchased Tesla shares June. 800 employees. Tesla shares began trading on the Nasdaq Stock Exchange and gained 40.5 percent

2012

- January. Tesla ended production of the Roadster to focus on the Model S
- February. Tesla revealed the Model X - a small SUV and says it will go on sale in early 2014
- June. 2000 employees. The Model S was officially launched at the Fremont factory. Retail deliveries of the Model S started in the United States
- September. Unveiled the Supercharger network

SpaceX

1957.Soviet's Sputnik 1 became the first satellite to go into orbit

1961.The Soviet cosmonaut Yuri Gagarin became the first man in space

1969.Neil Armstrong became the first person to walk on the Moon

1981.First flight of the Space Shuttle

2000.First long-duration stay on the International Space Station (ISS)

2001

- July. Elon came up with the idea to do space

2002

- June. Elon Musk founded the company
- December. 14 employees

2006

- March. First failed flight of the Falcon 1
- December. 224 employees

2007

- March. Second failed flight of the Falcon 1

2008

- August. Third failed flight of the Falcon 1
- September. First successful flight of the Falcon 1 and becomes the first privately developed liquid fuel rocket to reach Earth orbit
- December. 618 employees. NASA awards SpaceX a $1.6 billion Commercial Resupply Services (CRS) contract

2009

- July. Last flight of the Falcon 1 and becomes the first privately developed liquid fuel rocket to deliver a commercial satellite to Earth orbit

2010

- June. First flight of the Falcon 9
- December. 1200 employees. First flight of the Dragon capsule and becomes the first privately developed spacecraft in history to re-

enter from low-Earth orbit

2011

- July. Last flight of the Space Shuttle

2012

- May. Launch of first cargo delivery flight to the space station ISS
- September. First hop of the Grasshopper
- December. 2200 employees

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